DUDLEY KNOX LIBRARY
NAVAL POSTGRADUATE SCHOOL
MONTEREY, CALIF 93940

NAVAL POSTGRADUATE SCHOOL

Monterey, California

THESIS

A Feasibility Study of Incorporating
ARPANET Type Technology
at United States Naval Installations

by

Michael Gilbert Shaw

March 1980

Thesis Advisor: G. K. Poock

Approved for public release; distribution unlimited

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) A Feasibility Study of Incorporating ARPANET Type Technology at United States Naval Installations		5. TYPE OF REPORT & PERIOD COVERED Master's Thesis; March 1980 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Michael Gilbert Shaw		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Naval Postgraduate School Monterey, California 93940		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Naval Postgraduate School Monterey, California 93940		12. REPORT DATE March 1980 13. NUMBER OF PAGES 118
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office) Naval Postgraduate School Monterey, California 93940		15. SECURITY CLASS. (of this report) Unclassified 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

ARPANET

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This thesis investigates the feasibility of using ARPANET type technology at Naval Air Station, Lemoore, California. Aspects of functions on the ARPANET, their applications to needs in the United States Navy in general and more specifically their application at Naval Air Station Lemoore were investigated. Emphasis was placed on improvements in readiness, expediency, and efficiency, with discussion of monetary and man-hour savings where applicable. This is a baseline study for potential users to illustrate what can be

done in an operational setting. The study concludes that APPANET installation is technologically feasible, appears to be relatively inexpensive compared to multiple individual minicomputer installations, and has the added importance of being a significant management tool. Before implementing these ideas, further detailed analysis would be required comparing operating, maintenance and training costs.

Approved for public release; distribution unlimited.

A Feasibility Study of Incorporating ARPANET Type Technology at United States Naval Installations

by

Michael G. Shaw
Commander, United States Navy
B.S.E.E., Naval Postgraduate School, 1975

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN SYSTEMS TECHNOLOGY

from the

NAVAL POSTGRADUATE SCHOOL
March 1980

DUDLEY KNOX LIBRARY
NAVAL POSTGRADUATE SCHOOL
MONTEREY, CALIF 93940

ABSTRACT

This thesis investigates the feasibility of using ARPANET type technology at Naval Air Station, Lemoore, California. Aspects of functions on the ARPANET, their applications to needs in the United States Navy in general and more specifically their application at Naval Air Station Lemoore were investigated. Emphasis was placed on improvements in readiness, expediency, and efficiency, with discussion of monetary and man-hour savings where applicable. This is a baseline study for potential users to illustrate what can be done in an operational setting. The study concludes that ARPANET installation is technologically feasible, appears to be relatively inexpensive compared to multiple individual minicomputer installations, and has the added importance of being a significant management tool. Before implementing these ideas, further detailed analysis would be required concerning operating, maintenance and training costs.

TABLE OF CONTENTS

I. INTRODUCTION-- 8

II. THE ARPANET-- 12

A. HOW IT BEGAN-- 12

B. HOW ARPANET WORKS-- 13

1. Virtual Terminal-- 13

2. Microprogrammable Building Blocks IMP-------- 15

C. COSTS OF OPERATING ON THE ARPANET--------------- 17

1. Initial Costs-- 17

2. Recurring Costs-- 20

D. PROTOCOLS ON ARPANET-- 20

1. User Telnet-- 21

2. Netmail-- 24

3. File Transfer Protocol-- 25

4. Resource Sharing Executive------------------- 27

5. Network Status-- 28

6. System Status-- 29

E. GENERAL FEATURES-- 30

1. On-Line Information-- 30

2. Text Editing-- 31

3. Spell-- 34

4. Graphics-- 35

5. Archival System-- 36

6. Linking-- 38

III. APPLICATIONS-- 40

A. GENERAL APPLICATIONS-- 41

1. Data Transfer 41

2. Mail 44

3. Record Maintenance 47

4. Preformatted Messages/Reports 48

5. Training 49

6. Non-Specialist Assistance 49

7. Word Processing 51

8. Training Scheduling 52

B. SPECIFIC APPLICATIONS AT NAS LEMOORE, CALIFORNIA 52

1. Security 54

2. Aircraft Intermediate Maintenance Department 58

3. Medical 61

4. Naval Data Automation Facility 64

5. Light Attack Wing, Pacific 66

6. Squadrons 68

C. SPECIAL APPLICAITONS 73

1. QUERY3 73

2. LADDER 75

3. FSAR/SAR 76

4. MYCIN 79

5. ASTDA 81

6. SURVAV 82

7. RITA 83

IV. CONCLUSIONS 85

A. TECHNOLOGY EXISTS TODAY 85

B. COST IS RELATIVELY INEXPENSIVE 86

C. THE NEED FOR INTERCOMPUTER CONNECTIVITY EXISTS 88

D. THERE COULD BE A SAVINGS IN RESOURCES----------- 89

E. EQUIPMENT CURRENTLY EXISTS FOR INCORPORATION---- 91

F. ADDITIONAL RESEARCH IS NEEDED------------------- 91

APPENDIX A. LIST OF ACRONYMS AND GLOSSARY-------------- 93

APPENDIX B. FIGURES------------------------------------ 96

APPENDIX C. COMPUTERS USED ON THE ARPANET-------------- 104

APPENDIX D. UNITS VISITED AND POINTS OF CONTACT-------- 106

APPENDIX E. COMPOSITE STANDARD MILITARY RATE TABLE----- 107

APPENDIX F. COMPUTER LANGUAGES USED ON ARPANET--------- 108

COMPUTER OUTPUT-- 111

BIBLIOGRAPHY--- 114

INITIAL DISTRIBUTION LIST------------------------------ 116

I. INTRODUCTION

In August 1979 Secretary of Defense Harold Brown stated that the two-fold mission of the Defense Advanced Research Projects Agency (DARPA) was

> "...to explore the leading edge of technology to prevent technological surprise, and to exploit new developments by demonstrating technology payoff and presenting system options to the services."[5]

One of the ten areas of research effort for DARPA is in the field of Command, Control and Communications (C3) or Cee-cubed. Within this field is the Advanced Command and Control Architectural Testbed, frequently called ACCAT. One function of ACCAT is to explore areas of command and control in the United States Navy. The purpose of the ACCAT effort is to develop, evaluate and test hardware and software technology which will enable the naval commander to have the information available to make decisions in a time of crises as well as in everyday operations. These efforts have given the Navy many new technological advances in the C3 arena.

This author was introduced to some of those technologies at the Naval Postgraduate School (NPS) in Monterey, California. One technology in particular, a computer to computer packet switching network called ARPANET (for Advanced Research Projects Agency Network), showed a great capability for interconnectivity of command and control functions. Although not developed under the ACCAT project, it is a key information handling network used by it. As a conclusion to an academic quarter in which the author was

exposed to, and learned to use the ARPANET, the professor for that class asked for a short paper delineating possible ARPANET applications in each class member's parent service. That paper proved to be the initial motivation for doing this thesis.

Initially, the quarter assignment began with descriptions of routine tasks which could be better performed using ARPANET. As more and more investigation was made on the assignment, not only did the ARPANET appear to be more convenient, but also showed the possibility for interconnecting all major Navy activities on a single network. The author anticipated that such a network would improve the day to day command and control. To prove that, a survey of current methods of performing tasks needed to be performed to determine if there might be sufficient savings in man-hours to warrant connecting all bases on ARPANET.

The author had previously been stationed at Naval Air Station (NAS), Lemoore, California, and considering its proximity to the Naval Postgraduate School (NPS), chose to go to NAS Lemoore and investigate current methodologies of performing tasks that were compatible with existing ARPANET features. Thus in going into the fleet environment and discussing DARPA, ACCAT, IFCC, FCC, etc. it was discovered that most fleet officers and enlisted personnel had not heard of those terms. When those same individuals were also asked about ARPANET, blank stares were received. The author began to wonder if such a superlative job was and is being

performed in the area of development, why did the fleet not know of it? The answer was that transfer of technology was not taking place. In spite of technological advances for informing the commander of what the enemy is doing, and for calibrating and measuring his readiness, the day to day routine and mundane tasks of operating a unit were and are still being done manually in many many instances. It was that area, which was at such a basic level, that the author felt was in need of the greatest investigation. To that end, the desire of this author was to investigate the thesis that if the ARPANET and all of its capabilities were employed at naval bases in the United States, an appreciable amount of improvement would be made in efficiency and expediency of the everyday naval command, control and communications area. Additionally, this officer felt there would be a savings in man-hours and money to the extent that it would pay for installation of the required hardware and software. The effort of that investigation has culminated in this thesis.

General J.A. Hill, in an article in SIGNAL magazine stated the following,

> "An overriding concern must be effectiveness at least cost. Equipping individual tactical units with some electronic device implies large quantities."
>
> "But there is also a time to creatively combine what already exists and provide capable, reliable, economical systems that can be produced in sufficient numbers -- without adding to inflationary pressures."[10]

Thus, it is hoped that this thesis will encourage others

to investigate the overall improvement possible in efficiency, expediency and cost by using some of the technology available and applying it to areas which are still being performed in the manual fashion they have always been.

The second section of this thesis discusses what the ARPANET is, what it costs to install and operate, and what some of the various protocol are that can be accessed on the net. To this extent, the reader who is familiar with this information might better be served by skipping section II and proceeding to section III. A glossary of terms may be found in Appendix A.

II. THE ARPANET

A. HOW IT BEGAN

The ARPANET is a product of the Defense Advanced Research Projects Agency (DARPA). It began as a project in the late 1960s in which DARPA was looking for a method to tie together several DARPA-funded computer resources and form a national network by which those computers could interact. The key feature which made that effort standout from previous work was the idea of "packet switching" as opposed to the circuit switching which had been used so prevalently prior to that time.

Perhaps a brief explanation of what packet switching is, will help at this point. Packet switching is a method whereby small packages (packets) of information are sent out instead of one long message. Each individual packet of information has a header of address information added onto the actual message bits composing the information portion of the packet. With the address information available on each packet, the individual packet does not have to necessarily travel the same route electronically as did the preceding packet. At the destination these packets are then reassembled in the proper order to form an entire message. In this manner, several routes of travel are open for transfer of packets. This structuring is an economic factor in that far fewer trunks are required to send data. It was

this economy that DARPA was pursuing in addition to tying together its computer resources when it developed ARPANET. DARPA determined that packet switching would permit something in the nature of 3N/2 trunks to be used for N hosts to communicate rather than the previous N(N-1)/2 trunks required otherwise.[8] With 50 hosts, packet switching requires only 75 trunks as opposed to 1225 trunks. With a hundred hosts the number skyrockets to 30 times as many trunks required as when not using packet switching.

B. HOW ARPANET WORKS

1. Virtual Terminal

DARPA managed to tie together literally hundreds of computers and not require that all be of the same make by using a virtual terminal concept. They formulated a standardized terminal performance and connectivity to which any other make or type hardware would be interfaced if connected to the system. A given location could then use any one of a number of the computers on the network and each computer would be capable of communicating with any other. Appendix C lists some of the types of computers currently being used on the ARPANET system.

Terms which will be pertinent in this section and commonly used are Host, IMP and TIP. A Host is any site which maintains an onboard computer connection at its location, as opposed to simply having a terminal connection tying into the network. IMP and TIP both are the nodal connections to the ARPANET. Where those two differ is an

IMP is a connection for one to eighteen Hosts (a function of being an IMP or Pluribus IMP), and the TIP is a connection which can support both Host(s) and terminals. The TIP also comes in the TIP or Pluribus TIP versions, with only the PTIP versions currently being available. The IMP handles one to four Hosts whereas the Pluribus IMP handles multiple Hosts. The TIP handles one to three Hosts, but also supports up to 63 terminal connections. The PTIP is similar to the Pluribus IMP but handles up to 63 terminals in addition.[7]

Returning then to the virtual terminal concept, the Host system is asked to only have connectivity with a single (imaginary) terminal called the Network Virtual Terminal (NVT). The user's TIP translates the data he types to make it look like virtual terminal code, and translates the remote system's response back into his terminal's code. Virtual terminal code includes symbols which do not exist on a particular user's keyboard. Therefore, combinations of certain keys are used to represent that virtual code. That is where the control key, in conjunction with other keys, is frequently utilized.

The NVT has 128 keys, some in upper and lower case pairs. Those keys correspond to the full ASCII set. In addition, there are the control keys, like the "BREAK" key. The terminal is capable of full and half duplex operations under control of a user controlled switch. Thus, every TIP expects to receive and always responds in the Network

Virtual Terminal code.[4]

In the typical course of a user interacting with the ARPANET, four steps transpire. The user first establishes the hardware power to his terminal. Second, he establishes some type of dialogue with the TIP in order to form a particular set of parameters under which he is to operate. In the case of use at the Naval Postgraduate School, this is striking an 'r' or an 'e' to synchronize the signal and declare terminal type. The third step is to open a connection to the remote Host for operation. Finally, the user ignores the TIP and talks to the Host until logging out of that Host.

2. Microprogrammable Building Block IMP

The following information describing the MBB IMP was furnished by Martin Oakes of Bolt, Beranek and Newman. This is a new system currently under development at B, B and N. The intent is to develop a system that can replace the Honeywell 316 used for TIPs. The MBB will be more powerful in its computing capability while costing approximately one-fifth as much as the present equipment.

> The MBB Interface Message Processor (IMP) is a Network Node built around an MBB processor. The MBB is a 20-bit computer with Error Detection and Correction Memory. It is microprogrammable with a 32-bit microword length. Small boards can customize the processor, and together with microcode, allow

the MBB to emulate many 16-bit computers. As an IMP, it emulates the Honeywell 316, the basic machine of the original ARPANET Nodes.

The MBB IMP has 32k words of memory, and runs all H316 IMP software directly, and so has similar limitations. The basic IMP interface card supports 4 1822-style Host Ports, and 6 Synchronous Modem Ports. Modem Ports support either inter-node communication lines (LINKS) or Hosts connected using Synchronous Communication Ports.

The IMP software currently supports a maximum of 4 Host Ports (whether local 1822 or remote Synchronous) and a maximum of 4 LINKS. It also has a maximum limit of 5 Synchronous Modem Ports (whether LINKS or remote Hosts). In addition, the maximum number of ports supported in total is seven.

The MBB IMP is mountable in a standard 19 inch rack cabinet, and occupies 12.5 inches of vertical space. It draws 300 watts of power, either 60Hz 120v, or 50Hz, 220v.

Microcode must be re-loaded after power failures using a micro-cassette driver supplied with the MBB. A port on the MBB supports a standard ASCII asynchronous terminal for use when running diagnostics. The terminal is not

supplied but is only occasionally needed.

Initial load tests indicate that the MBB IMP can handle 1.8 to 2.0 times the throughput of a normal H316 TIP.

C. COSTS OF OPERATING ON THE ARPANET

When the costs for operating on the network were first investigated, it seemed that the idea of connecting all naval installations to the network would be prohibitive. However, once it was determined that a TIP could be utilized at an individual base with other bases accessing that Host by means of less expensive connections, the cost looked better, but still had a 'frown' factor when mentioned. Continued investigation has shown that research being conducted on the Microprogrammable Building Block concept would cost much less than installation of the TIP ($20,000 vice $95,910) and would have capabilities on the order of a Host. It was also determined that the overall initial cost for a naval base such as Naval Air Station Lemoore would be approximately $100,000 using existing equipment. The recurring monthly costs would be on the order of $5,400. Discussion of how these figures were achieved is in the following paragraphs.

1. Initial Costs

The items which were considered in the initial costs were the installation of the TIP or MBB at the base; the purchase of Cathode Ray Tube (CRT) terminals, and printer

devices; and the cost of the computers, (e.g. PDP 11/70s). The costs used for this purpose were taken from data on costs for TIP installation at the Naval Postgraduate School at Monterey, California and for GSA costs on equipment in the Aviation Training Support System (ATSS) at NAS Lemoore, California. The MBB costs were estimated based on information received from Bolt, Beranek and Newman which was doing the research on the MBB development at the time of research on this thesis. Costs for the peripheral devices like the CRTs, printers, and graphics terminals can spread over a great range depending on which models are desired, what functions are needed and to what system they are to be connected.

CRTs with modems (phone connection capability) are advertised retail by many stores for under $700.00 each. That price is on a par with the price paid for the Lear Siegler ADM-3 CRTs used at NAS Lemoore. Those particular CRTs cost $704 each and are compatible with ARPANET. Approximately forty-five terminals of this nature are being used with the Aviation Training Support System (ATSS) at Lemoore. From there the prices rise up to whatever the buyer desires to pay.

Printers, for hard copy output when CRT terminals are used, likewise vary in price over a great range. The Naval Postgraduate School had recently installed a laboratory for use in conjunction with the ARPANET. Three Tally Corporation model T1612 printers and one Digital Decwriter

II model LA 36 printer were installed. The Tally printers have a variable baud rate of 600 to 9600 in five steps and the Digital printer has a variable baud rate of 110 to 300 in three steps. Cost of high speed printers is in the very broad neighborhood of $3,000 to $13,000 and for the Decwriter around $1,500. There are several similar machines in the same general price ranges. The price seems to be a function of the baud rate, in so far as the printers are concerned.

The prices for the computers and magnetic tape were taken from the costs of the Digital PDP 11/70 and Dec Magtape TE 16. The price for the PDP 11/70 with 64K memory runs approximately $92,000. The Dec Magtape costs in the neighborhood of $24,000. NAS Lemoore had two RPL-4s with 88 megabit storage which had cost $72,000. That was in addition to the PDP 11/70 they also owned. Thus in the current case the computers already exist at the naval installation at Lemoore and can be made compatible with the ARPANET via software. Figure 1 in Appendix B lists the hardware in existence at NAS Lemoore at the time of the research.

Considering existing hardware, the initial installation costs for a Plurious TIP (multiple host, 63 terminal capacity) at NAS Lemoore could be as little as $15,600+. That would be $3,100 for the first Host interface, $12,500 for the software license fee and $431 for each two port LIU card. An LIU card is required for each two terminal ports

desired. However, with all the activities on the base that showed desire to be on such a network, it would just about be imperative to add at minimum one more PDP 11/70. With that the initial cost would rise to something in the vicinity of $100,000.[7] Figure 2 of Appendix B compares estimated costs for installing several individual minicomputer systems with installation costs for an ARPANET TIP.

2. Recurring Costs

The recurring costs for the system are very straight forward. A yearly estimate is made and is based on the overall ARPANET operating and maintenance costs divided by the total number of IMPs and TIPs. For the fiscal year 79 and fiscal year 80 the estimate was $6,496 per month. Contact on the ARPANET with Larry Avrunin indicated that the recent ARPANET installations at the Navy laboratories have been running in the neighborhood of $5,400 per month. As more and more nodes are installed, the individual recurring costs per node are dropping. One benefit of the diligent maintenance effort has been an operational availability, on the network, consistently in excess of 99 percent.

D. PROTOCOLS ON ARPANET

Certain programs have been written in order to achieve varying degrees of usefulness within the ARPANET system. Once a requirement was established and a program was standardized to operate on the system it was introduced as a protocol. Protocols then are methods where certain

operating procedures that are followed allow a user to attain a much greater degree of flexibility in his use of the ARPANET computers. The development of protocols is an on going program, and as new features are seen to be needed, a new protocol is standardized and introduced. By building the protocols towards the concepts of the virtual terminal they can be used anywhere in the system. Following is a list of six of the more frequently used protocols available on the ARPANET system. The latest ARPANET Resources Handbook available at the writing of this thesis listed 17 separate protocols. Not all protocols are found on every Host in the network. The ARPANET Resources Handbook should be consulted for a listing of which Hosts have which protocols available. The latest issue is the February 1980 copy.

1. User Telnet

More commonly called telnet, this protocol was designed to provide a means wherein a user could communicate with various Host computers and also utilize other features on a Host other than the Host which he initially logged on. This multiplexing of the terminal among several remote jobs enables the user to have access to multiple directories at the same or varied hosts and be able to work all of them without logging out of one prior to working in another. Additionally, the protocol as written is unique in two ways. All instructions are entered into the system by use of a command-interpreter. The command-interpreter only

recognizes those commands/keystrokes which it understands. If the user is unfamiliar with what is next expected he need only type a question mark and the command-interpreter prompts him.

Commands which are typed into the system can be used either to talk to the Host computer to which the individual is telnetting, or they can be orders to a program at that Host. The commands to the Host are those which can be understood by the command-interpreter. Those commands are the ones used in making the connections, giving orders to establish various specific program functions for that telnet session, or disconnecting. Once those commands have been given, the user then is virtually able to operate on the other Host just as he has been on his initial Host.

In order to telnet to another Host the user has to know the name, password and account information for the directory he will use once the telnet connection is started. In some instances it is possible to telnet, not login and still obtain information from another Host. Features such as mail checks, status checks of the system, determining if a certain user is on another Host, etc. are included in the system.

In addition to the standard connection and disconnection features the telnet protocol has also been written with other features to make it a more flexible tool. A capability has been added so that a user can establish multiple connections. With this multiplexing, several

simultaneous actions can be carried on. Within this, the user affixes a name to each connection made and he can then, at will, retrieve any particular connection with a "retrieve.connection.name" command. Features have also been made such that the user can command the computer to keep track of all his non-current connections and notify him if there is output activity on any of them. Another feature is one seen on radio frequency scanners like CB radio operators use today. This feature uses a command enabling the user to have the computer watch for the active connection and automatically switch to that connection as it comes active.

A final feature to be mentioned is the one which enables a user to keep a file of a particular session at the terminal. By commanding the command-interpreter to make a typescript at the beginning of the session, the individual is able to have in his directory at the end of a session a copy of every item typed on the terminal. This is particularly useful in a situation where an individual might want to use the terminal in the active telecommunications mode (linking) and have a copy of the conversation when through. The telecommunications mode will be discussed in more detail later. However, to clarify the last comment, it should be noted that linking is similar to a telephone conversation between two individuals, except the conversation is input via the keyboard on the terminal. In all other respects it is as real-time as is a telephone conversation.

2. Netmail

Mail, MSG, HERMES and others are all mail-handling programs which enable the user to format, file, send, receive, edit and in general handle mail or messages. They were designed as an electronic postal system with no stamps, envelopes or retyping of messages which had been received and were to be forwarded. The netmail system was made to be fast, efficient and in some systems given a text editing capability. Features and commands are made available where the user can perform many of the functions such as answering, or forwarding of mail with only a single keystroke to obtain the addressee, his address, which letter is being answered or forwarded. If additional comments are desired, they are, and then the new message is forwarded, again with a single keystroke. In most cases the author experienced while using various forms of the netmail protocol, the messages arrived at destination in less than two seconds. In the event the Host where the message is to be delivered is off-line, the system has been given a feature wherein it queues all mail and forwards it immediately when the other Host returns on-line. All systems the author has used have a feature where the user is notified when logging in that he has new mail awaiting examination. He is additionally notified, when running a different protocol, if he has new mail upon returning to the executive level of the ARPANET. For mail which cannot be delivered (e.g. the addressee directory is no longer active

at that Host) it is placed in the sender's directory under a file normally labeled unsent.mail or a similar name.

A great deal of latitude is given in how particular systems are managed. In most, a feature exists where the user can examine only the headers of the mail. The headers are formatted bits of information which list date of receipt, sender, subject and in most cases the length of the message. In this manner the user can skip the longer messages when he is short of time to read all of the mail. However, when a message is received, it is annotated with a symbol showing that it has not been read. When the message is read, that symbol is dropped. In this way the user is able to call up headers only, and see which messages are unexamined. As with new mail, unexamined messages are also reported when the user logs onto a system.

3. File Transfer Protocol

FTP, as it is more commonly called, is exactly what the name implies. It was written as a protocol to enable the transfer of information packages within the ARPANET system. For most of the Hosts, the user is required to know a directory name, password and accounting information. However, in some an anonymous login is authorized or the files are in what is called a public access directory and therefore require no access accounting information.

The FTP feature of the net is to data transfer, what Ford was to the automobile industry in mass production. During the author's nine months of using the ARPANET, files

were frequently needed which were in another directory, such as at the Massachusetts Institute of Technology. By use of the FTP feature, those files could be transferred to his directory at the Information Sciences Institute at the University of Southern California at the rate of nominally 250 milliseconds per packet. In the majority of the cases this meant receipt of files which were equivalent to forty or fifty typed pages in less than a minute or two. Frequently those files would take as little as ten to fifteen seconds to be transferred.

The commands to transfer the files are as simple as typing the word "get", followed by the name of the file as it exists where it is being stored, and following that the name the user wishes to give it in his directory of files. FTP is not a one-way protocol. The capability also exists to send a file as well as to get one.

The heaviest use of FTP most likely occurred during the author's initial stages of learning the ARPANET system. On-line documentation was maintained at the Stanford Research Institute (SRI). Thus, when information was desired on a subject unfamiliar to the author, it was simple to FTP to SRI, get the desired documentation, and transfer it back to be studied when time permitted.

All objectives of FTP were found by the author to have been met. Those objectives were 1) to promote sharing of files (computer programs and/or data), 2) to encourage indirect or implicit (via programs) use of remote computers,

3) to shield a user from variations in file storage systems among Hosts, and 4) to transfer data reliably and efficiently.[16] FTP was found to meet the needs of the network user, regardless from which type facility he was working.

4. Resource Sharing Executive

The Resource Sharing Executive (RSEXEC) is a multi-computer executive program. It provides an environment in which the range of many features found on a single Host time-sharing system are extended beyond the boundaries of a single Host to encompass many Hosts on the ARPANET. As of the writing of this thesis, RSEXEC includes facilities for inter-Host user-user interaction for managing "multi-Host" file directories and for controlling multiple "jobs" on several Hosts. In addition, the RSEXEC serves as a command language interpreter for TIP users.[11]

Perhaps the best way to make the RSEXEC protocol more easily understood to the non-ARPANET user is to describe some of the commands. Comparing what they do in relation to what the similar commands for the normal executive level do should make the function of the RSEXEC clearer. In total there are thirty-nine different commands available in the RSEXEC protocol. They are all effective any time after the user types 'RSEXEC' at the normal executive level and until the 'QUIT' is typed in the RSEXEC level.

As previously mentioned, the LINK command normally

allows a user at a Host to telecommunicate real-time with any on-line user at the same Host. In RSEXEC this same command allows the same function but it is not restricted to a user at the same Host. Thus when the author is logged in at Host ISIC and wants to LINK to user POOCK at Host ISIE the command is LINK (to) POOCK (at Host) ISIE followed by a carriage return (<cr>). The telecommunications link is established between Hosts. In the preceding example the user types the capitalized words followed by a strike of the 'escape' key. The computer then types the lower case prompts to the user.

Similarly, when logged in at one Host a user can type the command WHO (at site) HOSTNAME <cr>, and the system checks the other Host listed as HOSTNAME for all active jobs. If a user does not know at which site the individual he desires to contact is logged into, the WHERE command is used. By typing WHERE (is user) POOCK <cr> the user can determine if POOCK has any active jobs at a site with RSEXEC servers running. For the normal executive level these same commands perform similar functions, but only at the Host at which the user is logged in at that time.

5. Network Status

The Network Status or NETSTAT is a protocol that was established to allow the user to determine the status of various system functions. To use the protocol the individual types NETSTAT which places him in a lower level of the system. After this several commands are available to

the user to determine such things as the status of sites and connections, the status of all sites, the status of Hosts only, the status of all connections etcetera. The NETSTAT also has a verbosity feature where the user can ask for brief or verbose readouts on the particular item for which he is inquiring about the status.

Commands are also available for more specific inquiries. An example is the ability to get Host readouts with either decimal numbers of the Hosts or with octal number readouts of Hosts. By commanding SPECIFIC the user is also able to ascertain status of particular connections such as, connections relative to specific jobs, connections with specific byte sizes, connections with specific teletypewriters, etcetera.

It was found that few members of the classes that had taken the ARPANET course (Man-machine Interaction) used the NETSTAT protocol. More frequently they used the SYSTAT protocol which is described next.

6. System Status

The System Status or SYSTAT protocol is for use on an individual Host to determine the status of a particular individual (done by typing SYSTAT USERNAME<cr>), or for determining the status of all current jobs on that Host (done by typing SYSTAT<cr>). The user is then given information of date, time, number of user jobs and number of operator jobs, and the load average at that time. That is followed by a list of each individual job, by job number,

teletypewriter number, user name, and program he is running. In the event of the former command entry, that same information for the individual requested is furnished.

Although there are other protocols available on the system it is not felt that it would be of any benefit to the reader to understand them for purposes of this thesis. However, the next subsection will discuss some other features and capabilities found on the ARPANET during the author's use. These are not considered protocols as such and are therefore listed under a general feature section.

E. GENERAL FEATURES

There are many features which are not considered as standard as the protocols, but that are frequently found available at the executive level of many of the Hosts. Some of the items almost seem necessities while others would have to be considered frills or nice-to-haves. The following sections will then discuss a few of the features the author either considered functional or interesting, and those which have been frequently utilized.

1. On-Line Information

When given a directory at one of the Hosts, the user's directory of files is usually named in a format which is similar to the following, <USERNAME>FILENAME.EXTENSION.VERSION. The USERNAME is the name used in conjunction with a particular directory. The FILENAME and EXTENSION are assigned by the user when creating files and can be any combination of letters and

numbers up to thirty-nine characters for each. The VERSION is a number and is assigned incrementally to that particular file each time it is written or rewritten beginning with 1. The system does not mirror the <USERNAME> of the file as it assumes the directory desired is that of the username utilized at login to the system.

Each Host maintains on-line documentation of the various programs and protocols that are available at that particular site. The directory, not unexpectedly, is called <DOCUMENTATION>. Hence, to get a listing of what subjects are on-line an individual user can ask for a print of DIRECTORY<DOCUMENTATION> and he is then able to review the subjects of all the on-line information available at that Host. With this knowledge a user can FTP files from that directory or simply printout the file on a hard copy device as required.

Likewise, the ARPANET maintains on-line information at Stanford Research Institute in a directory with the name <NETINFO>. It is accessible to users netwide. In the same directory are files of all working/point papers that have been written about and for the network since 7 April 1969 shortly after its inception.

2. Text Editing

Although most ARPANET users refer to the program as text editor, the term common to the business world is word processor. There are several text editors available on the system. One need only find the one compatible to his

equipment and to his own liking and then use it. The editor used initially was the XED (experimental editor). It has commands which enable the user to create, append, insert and adjust text in the editor, then save it in a file in his directory. There are formatting and output modes available which allow things such as right and left justification of the text margins, options of double or single spacing, various schemes for lettering the individual pages, adding headers on each page, etc.

The XED program also has a feature where the user can compose text, such as the contents of a message or letter, then drop to a lower fork (e.g. a lower level of the network) in the system while invoking a message sending capability as described in Netmail. It is equally possible to invoke the XED from the Netmail protocol.

An even more powerful editor at some Hosts is one called TECO. It is more concise than the XED in that it allows the stringing together of multiple commands, followed by the execute character, and several operations are then performed from one entry. With the XED only one operation is permissible at a time.

The best editor the author had the opportunity to work with was the NED (for new editor) which is running on the NPS Host in a UNIX system. In fact, this thesis was composed, edited, formatted and output from an Ann Arbor terminal using the NED and NROFF programs. The UNIX system mentioned operates with the 'C' programming language. C was

originally designed for and implemented on the UNIX operating system on the DEC PDP-11, by Dennis Ritchie. The NED program, in addition to the regular keyboard characters, has arrow keys for moving a cursor. The cursor defines the position for all functions which are performed on the CRT screen. With NED the text can be opened or closed. In other words, if the user desires to insert extra text or an additional paragraph in existing material, the open function will add multiple blank lines between text. The remaining text is adjusted accordingly. The new information is then typed into the blank area. If too many blank lines have been allotted, the close function eliminates those lines and adjusts remaining text. Items such as paragraphs or whole chapters can be extracted from one position in the manuscript and inserted at another. If desired, the operation can even transfer sections from one file to another. Windows can be opened in the primary file and another file brought in from which information can be read, or shifted. A search capability exists either by cursor definition or by typing the string desired. Strike over capability exists for changing typing errors, plus characters can be inserted or deleted, and the text automatically opens or closes the entire string of characters to justify the action performed.[2]

Once the author had been exposed to the text editing capability on ARPANET, no further term papers were written by hand, corrected and then typed. Where the author had

previously taken a week to compose, edit and type a smooth copy of a report, the text editor enabled a report of the same length and content to be typed smooth in one and a half days. An assessment, by the author, of the capability to output smooth paperwork by means of a text editor, as opposed to even an electric typewriter, indicates that one secretary or yeoman can produce as much in a given period as three other equally capable secretaries or yeomen.

From an evaluation standpoint, one of the most beneficial features is for the manager who is a mediocre typist to be able to output smooth copy in less time than it would take to have the same information written by hand and then typed smooth. In one instance, the author composed and output a smooth visit request on the ARPANET in an hours time. That request was given to a secretary to be typed in the standard manner. Because of workload and typing requirements the request was delayed over two months in leaving the office. Thus, the text editor enables much paperwork to be processed by the manager in less time than normal and without use of a secretary.

3. Spell

Spell programs are available on most of the Hosts with which the author has operated. It is a program designed to read text files and check them for correctness of spelling. In addition to the spelling check, the program provides a means for correcting words that it thinks are misspelled. The program was originally written by Ralph E.

Gorin at Stanford University and has been adjusted for the systems on which it is operating at this time.

Each Host's spell program operates slightly different, but essentially all have a large dictionary (42,000 words). In the normal mode of operation the user invokes the spell program, is asked if he desires to augment the dictionary and then is allowed to input a particular file for the spelling check. All words the spell program does not recognize are dumped into a separate file for inspection. There are procedures where if a misspelled word is located by the program it queries the user. The user can then inform the program that the word is in fact misspelled. From that point on, anytime the program finds the same misspelled word, it is automatically corrected. Of course the program also rejects words that are no match due to typographical errors.

The user has one other important option. He can invoke varying degrees of accuracy. This is done by the program stripping off prefixes and suffixes and then looking at only the root word. It reduces the running time but also opens up the possibility for more errors in the final product.[17]

4. Graphics

There are several graphics programs on the ARPANET. Some are tied in specifically with a program, such as WES (a war gaming model), and LADDER (described elsewhere in this thesis). The one graphics program on ARPANET the author was

exposed to was Level 2 Graphics, more commonly called GL2, which is at the ISI Host. GL2 is designed as a device-independent graphics system for use in the command and control environment. It has the capability to do calligraphic and bit-map displays. The design allows for its use on greatly varying terminals and permits use on systems which do not support color, shading or multiple device input. With a built-in inquiry capability, the application program is able to determine the characteristics of the display device to which it is connected. That allows the fullest use of a given terminal.

The following constructs are provided for in the GL2 graphics system:

-Establishing and breaking a connection with the desired display device.

-Allocating a graphics output area of a specified aspect ratio on the display device viewing surface.

-Defining a viewport (subarea within the allocated area of the display surface) and user coordinate system to be mapped to that viewport.

-Creating, merging, destroying, displaying and erasing named segments.

-Generating graphics entities such as lines, dots, text, arcs, and shaded polygons and sectors.

-Controlling display characteristics of graphics elements (e.g., intensity, color, text face and shading parameters).

-Accepting data from the terminal.

-Retrieving device/system status information.

-Sending and receiving device-specific

orders.[3]

5. Archival System

At most Hosts an archival system is established wherein a user's on-line, disk stored files are removed to tape storage if they have not been active for one months time. The purpose of the archive is twofold 1) it provides each user with a large, long-term storage capability and 2) it provides the system with a mechanism for freeing on-line storage. In its initial inception the program needs human operators at the Host to enter and retrieve files as required. However, the ultimate goal is to eventually go to a fully automatic system. Presently, if the file has not been used for the specified time the operator will output that file onto tapes (2). The tapes each have address locations, and those addresses are then listed, with the name of the file archived, onto the users file called ARCHIVE DIRECTORY. That particular file is stored on disk in the user's normal on-line directory. In this method, the system on-line storage is greatly enhanced and the user is not limited as to amount of total file storage available. If a particular file is required from the archives, it usually is back on-line within fifteen minutes of the request to the operator.

In instances where the user desires to have a file archived without waiting for the month's dead time he can invoke commands to the operator. These indicate that the file is to be removed from disk at the next dump. Th dumps

or removal of files from disk to tape, are normally performed once each week. This serves to free more disk space for the user who is normally limited to a specified number of pages of active storage.

6. Linking

The linking feature is a real-time telecommunications available on the network. Depending whether the user is at the normal executive level or the RSExEC level he can link to other users at his Host or at a distant Host. The command is LINK (to) NAME <cr>, and the computer will make the connections required to permit contact. On one Host the command is TALK instead of LINK. With the link feature, an individual experiencing any difficulty with a particular feature can get assistance from any other user that is on-line. Anything that is typed on one terminal is echoed on the other. When initially learning to use the ARPANET, a student can be at home on his terminal and link to the instructor for assistance. The instructor types the required commands to perform the desired action and the student is able to observe each step as it happens. As it turned out, the students at NPS were assigned terminals that output on hard copy, and that demonstration could be saved. In the event the student is using a CRT type terminal, the student can invoke the typescript to file feature mentioned previously. Upon linking he then has a file of the transaction.

As could be expected, there were times a user did

not desire to be disturbed or interrupted. For those times it was possible to refuse links and/or advice from another user. If that feature had been selected, the terminal sounded a series of six tones when someone attempted to link to that terminal, but no interruption of the program in process occurred. At the same time, a message was automatically sent to the individual attempting the link. The message advised that the link had been refused and mail should be sent to the individual instead.

III. APPLICATIONS

The applications for ARPANET to the military establishment are limited only by the user's imagination. Discussion with members of the Naval Postgraduate School faculty who have used ARPANET for some time revealed, that for the vast majority, they learned something new each time they were on the system. Of the approximately 22-25 students per class who had completed the Man-Machine Interaction class (an introduction to the ARPANET), 100 percent retained their terminals until they graduated. Of those, 90 percent or better claimed they used the terminal daily. Some of the students exposed to the ARPANET via the Man-Machine Interaction class were able to do continuing work for ARPA after graduation, and stated that that capability was invaluable to their daily work in their normal billet. However, testimonials alone do not show ARPANET's value to the military. In that light, the next section is to discuss the applications of the ARPANET in three ways. First will be a discussion of general applications of the network protocols as they could be applied to day-to-day naval C3 administration and operations. Second, the specific applications as determined by investigating NAS Lemoore tenant activity operations will be discussed. In that subsection, assessment of man-hours required for certain jobs will be presented, and specific savings that could be shown are illustrated. Here the point

needs to be stressed that man-hour savings does not indicate firing anyone. As recruiting and retention problems in the Navy persist, it is imperative that managers have better methods to perform all job requirements that contribute to readiness. Discussion of those methods is meant to indicate the ability to better perform a job with fewer people. Third, a subsection describing special on-line aids which have already been developed is presented. The last section is not all inclusive but discusses special aids that were used by the author while at NPS and showed naval application.

A. GENERAL APPLICATIONS

1. DATA TRANSFER

If all the protocols had to be examined and a value given to each, it is this author's opinion that the capability to transfer data would have to be singled out as the one most valuable in making the ARPANET different from other computer systems. It is that special feature, which demonstrates that several minicomputer systems by themselves still can not satisfactorily achieve all that is needed to totally go to computerized database management, and more importantly continuity in command, control and communications.

The first area which came to mind for the use of data transfer was in the management of individual's military records. The average enlisted man is transferred every four years once he joins the fleet. Before that he is

transferred from recruit training to an A School (specialty training), and upon completion of A School to a Fleet Readiness Aviation Maintenance Program (FRAMP). Then he goes to the squadron or operating unit. With each move the individual either physically carries his records or has them mailed to the nest successive command. The records involved normally consist of his service record, medical record, dental record, training record, and pay record. The same records are applicable for officers, with the added point that most officers transfer every two to two and one-half years. No official data could be gathered on the number of records which are lost. Discussion with personnelmen, disbursing clerks, corpsmen and the training yeomen all virtually produced the same response, "Too many!" Further discussion indicated that an estimate of two or three single record losses per unit per year was not inaccurate. Although that statistically is only slightly over 0.25 percent it is still far too much when it is considered that some of the data cannot be reconstructed in certain records. Thus, if ARPANET capability were available at all naval facilities, or at least the major facility when more than one facility was located in the same geographic proximity, all record transfers could be handled via FTP. The added feature of that capability would be a savings of man-hours where the same data is stored on computers in both locations. The key is that the commander could ascertain exactly what training the man has received, what will be

needed and how it will affect the unit's readiness if it is not achieved. All of that can be achieved without waiting until the records are hand carried by the individual.

Another area of general application envisioned for the data transfer feature is in distribution of the myriad of military instructions. The amount of time and money spent each year by all the Navy's individual units in maintenance of instruction files is tantamount to all the other administrative requirements. Commander William Paschall, head of the Navy's paperwork control office, stated there are almost 3600 Chief of Naval Operations (CNO) instructions and a massive effort is underway to pare those down. As an asset to paperwork, six fleet units are presently working with 'word processors' to aid in reducing the paperwork problem. Commander Paschall stated that a word processor in the CNO's mailroom had saved $50,000 yearly.[15] Inspection of any unit's instruction file will reveal the cascading effect one instruction at Secretary of the Navy (SECNAV) or CNO level has on the system. Almost to the unit, each office in the descending chain of command references the higher instruction, in one written at its level to amplify what was said at the higher echelon. By the time the squadron-level unit is in a position to act on the SECNAV or CNO instruction, there are normally no less than three or four other amplifying instructions. As each one is added and mailed it slows down the process of the lowest unit being able to establish the program required.

If all of the levels of distribution are counted for each instruction, one could most likely determine that one instruction at the highest administrative level generates the use of at least a truckload of paper. With the ARPANET, the instructions can be left on-line for access by the general user. That is currently done with documentation and special system point papers for the ARPANET users. The individual then has the alternative of scanning any document on-line for his immediate needs, or transferring it to his account where needed on a routine basis.

Of course the intangible benefit from having the capability for data transfer has been the 'immediate' acquisition of data when needed. An individual does not have to fight for an AUTOVON telephone line, to reach a person, who is not in his office, who is the only one that can be asked to mail a copy of some document that was needed last week.

2. Mail

There was no way to determine how much time could be saved by using the ARPANET Netmail protocols for mail as opposed to using the U. S. Postal System. Additionally, the author had no method to determine how much is spent each year, in the postal system, carrying and delivering franked government mail. Throughout the nine months of using the ARPANET, the one item that was checked daily, without fail, was the user mail. When on temporary duty assignments (TAD) away from the Naval Postgraduate School the author was able

to remain abreast of what was taking place at the school via the mail system. On occassion, assignments were even completed while TAD and mailed via the system to the instructor. Time for even lengthy mail to be sent was nominally under five seconds.

Even in instances where an individual has not had trouble obtaining an autovon telephone connection, or the called party has temporarily been out of the office, much time is spent calling, being preempted, and recalling. With the mail system, it is simply a matter of sitting down at a terminal in the morning, typing the messages for the day and mailing them. Then business is as usual until later in the day when the network is again checked for responses or new mail. The added feature is that a record is also available using the mail, whereas the telephone sometimes leaves doubt as to what specifically has been said two or three days previously.

Both of the above items certainly have application to NAS Lemoore or any other naval facility. Each unit on a naval installation routinally sends several memorandums per week. The ARPANET mail system could greatly shorten the time for delivery of those memorandums. Combine that with the capability to do text editing in the mail shell and typing time can also be reduced. Many the time this author sat as an Administrative Officer watching the new yeoman restart simple memorandums because of typing errors.

One noteworthy occurrence where the mail system

would have been of great assistance was over a letter of instruction (LOI) sent from a carrier airwing commander's staff to a squadron. The letter had been expected and when it did not arrive a phone call was made from the squadron to the staff. The answer was obvious, the letter of instruction was mailed and the staff asked the squadron to wait just a couple of more days. After that two days another call to the staff was made. The staff too agreed that the LOI was hopelessly lost and agreed to mail a new copy that day. Five days later the second copy arrived. Total delay from staff mailing of the first copy until receipt of the second copy by the squadron was twelve days. Had they had access to the ARPANET mail system the LOI probably would not have been lost to begin with. In any event, a second transmittal would have taken no more than five minutes total to delivery. The result in the instance cited was that the squadron without the LOI had to go to its sister squadron and xerox a copy of a rather large document in order to have its planning completed on time. Time and money were both wasted. Additionally, less than effective time was allowed for the planning of a readiness measuring deployment.

A great problem in the whole military organization has been a saturated communications system for message traffic. The solution in the past has been to impose MINIMIZE, a procedure which essentially stops routine administrative traffic from being sent. If ARPANET were

incorporated into naval installations it would serve to augment the already over used naval telecommunications system and would still offer a means for transmitting unclassified, routine administrative message traffic during times when MINIMIZE would be imposed. A second benefit would be that the network mail would arrive much faster than the current Routine category message traffic has in the past.

3. Record Maintenance

Maintaining records on computer systems is not new to the Navy. The function of each Aviation Training Support System (ATSS) on a naval air station is to maintain enlisted person's training records and training history. Slowly that has been expanded to include other data required for documenting advancement, maintaining recall files, etc. From that standpoint little more needs to be said. The requirement is present, it has been recognized, and a system is functioning.

What is interesting is the duplication of information. The Navy only recently instituted the Personnel Support Detachment (PSD), which is fundamentally established as a centralized activity to maintain personnel and pay records for all personnel on a naval installation. Some of the data is similar to that being kept at the ATSS. The point that should be stressed here is that the PSD unit and the ATSS have no method to transfer that common data computer to computer. Even more disappointing is that the

individual PSD units do not have the capability to exchange information between themselves computer to computer either. An ARPANET system could solve that problem.

4. Preformatted Messages/Reports

In the naval organization an officer is not solely an aviator, or a ship driver, but he is also a manager. He must lead men and manage the administrative matters which are pertinent to those men. To accomplish that end most young officers have been placed in a squadron collateral duty billet for six to eight months. At the end of that period they have been transferred to a different billet to be exposed to something new. Hopefully, by the time each is eligible to assume command he has been in most of the squadron billets. The point is that each time a recurring report or message has been due, an officer has spent much time with the proper publications to produce that report. The time spent has not been of necessity to gather the proper data. Normally it has been spent in trying to format the report in just the specific order that was established by those who must read several of the same reports. Likewise with annual reports, the senior yeoman spends much extra time in formatting a report he has not seen for some time. With the ARPANET there exist programs which, when selected, query the user. When finished with the query, the program takes the answers given, places them in the proper position in a preformatted message, and in a matter of only minutes produces a formatted message/report. A further

example is cited in the description of FSAP, in this section under special applications.

5. Training

In peacetime operations the word is training. All evolutions in the military are aimed at training for the eventuality of war. To that end, the capability exists on the ARPANET that enables building various programs to train an individual at the keyboard. The author found nothing in existence quite so fancy as the specialized computer based instruction developed by corporations such as Hazeltine, but there exists the capability to build programs that can achieve training objectives. Within Unix, using the C programming language, data can be exhibited and then followed up with questions. That is comparable to a programmed text except that it is on-line. For items such as the simpler tests required for promotion to E-2 and E-3 these methods are more than satisfactory. If one desires to go into greater depth, then other languages are available to build such programs. A typescript of a session on the Unix system using a simple program written in C can be found in the computer output section. That program was written by an individual who professed to be anything except a computer programmer, this author.

6. Non-Specialist Assistance

The Navy frequently has been finding itself in a position with not enough qualified personnel. The result of that is that many billets requiring specialists have gone

vacant in recent months. Additionally, there are areas where a specialist might be only occassionally needed and therefore the billets are not filled. An example is the lack of a doctor onboard destroyers. Even at the Naval Hospital at Lemoore, as at many installations, the shortage of doctors has led to the use of Physician Assistants. On the ARPANET there exist programs to assist the nonspecialist in diagnosing certain medical problems. These are at present in strictly an experimental phase. However, they do demonstrate what capabilities exist for assisting non-specialists. The one the author worked with (MYCIN) is described in more detail in the third portion of this section. Others that are developed and can be found on the network are CONGEN, and PARRY. Four in development are MOLGREN, PROTEIN, PUFF-VM and the MISL Project.

CONGEN - CONstrained structure GENeration accepts known structural features of an unknown molecule and produces all structural isomers consistent with that data. It is an initial version of a program for computer assisted structure elucidation.

PARRY - is an interactive simulation of paranoid thought process. Users conduct first interview with PARRY to obtain a diagnosis.

MOLGREN - a molecular genetics program

PROTEIN - protein structure modeling

PUFF-VM - for pulmonary function description management, includes mathematical modeling of physiological systems.

MISL - medical information systems laboratory

The foregoing are all medical programs at the

Stanford University Medical Center on the ARPANET. That Host (SUMEX-AIM) is used primarily for artificial intelligence management.

7. Word Processing

The capabilities for word processing have already been mentioned for the most part under the discussions of text editing and message traffic handling. The reason it is mentioned here separately is because of the great need seen in naval units for improved handling of correspondence. Standing procedure in the U.S. Navy, for correspondence, has been to permit up to three pen and ink changes to any official correspondence leaving a unit for higher authority. Yet in the seventeen years this author has served, he has yet to see a commanding officer let correspondence that was less than letter perfect leave a unit. The result has been that many many hours have been wasted retyping that paperwork. The end result has been a decrease in efficiency within a unit and poor use of manpower as a result. Hence, instead of using middle manager yeoman personnel to do managing, they have been used to do the typing of important paperwork, important in that it was going to higher authority.

In the Navy Times article previously citing Commander Paschall, it was pointed out that one squadron, using a word processor, had reduced its administrative workload by forty percent, in only two months. The Navy Manpower and Analysis Center, Atlantic, has estimated that

ultimate savings can be fifty percent.

8. Training Scheduling

The final area of general application to be discussed is the scheduling of training. The problem really needs no verification. The primary purpose of the Aviation Training Support System (ATSS) computers is to track and project training needs at the naval air station. The problem is that it was established for the enlisted person only. With approximately 22 officers in each A-7 squadron the need also exists to track their training. At present that is all being done manually. Why the service recognizes the need in one area and not the other is not clear. In the naval training situations there are so many varying factors that each squadron has an officer whose collateral duty is training and another whose billet is scheduling. Planning, scheduling, tracking, projecting and insuring that all training is performed is virtually the singular goal for each unit. It is the proper completion of that objective which insures the readiness of the United States. The preparation of the navy's fighters is still being accomplished manually.

B. SPECIFIC APPLICATIONS AT NAS LEMOORE, CALIFORNIA

Some background information is appropriate here. Naval Air Station Lemoore was chosen for investigation of ARPANET application for two reasons. First, the author had been stationed at Lemoore, California since 1970, for various periods of time, and was therefore familiar with most of the

base tenant activities (units). Second, the close proximity of NAS Lemoore to the Naval Postgraduate School (NPS) facilitated the numerous trips required to properly research the most current operating methods at the time of the thesis writing. From the last time the author was actively stationed at Lemoore (October 1977) until the beginning of the thesis research (August 1979) some changes had occurred. Wherein the base had previously had no real-time computer input/output except for the ATSS (formerly VTS) there were two units with recent acquisition (mid 1979) of that type equipment. The remaining activities investigated had either generated administrative procedures to attempt to acquire computer hardware or indicated they had recognized the need for such equipment. Appendix D lists in detail the units visited, and individual points of contact.

It is interesting, though not surprising, to note that only in one area has application on a navywide basis been considered for real-time connectivity. That one area is the Personnel Support Detachment (PSD). The remaining activities have individually recognized an inhouse need for real-time computer application for their operations. To that end, the applications considered were predominantly to satisfy problems only on a local level. Most of those applications could have conceivably been satisfied by a stand alone minicomputer system such as a Wang 2000, TRS II etcetera. Once the demonstration of the ARPANET was completed, discussion immediately tended toward the

information interchangeability that was possible basewide and navywide with ARPANET. In every instance there was data/information required on one unit's system operation that was necessary in at least one other base unit's operations. In most instances the same data/information had to be shared among several units. That interchange of data, computer to computer, could not be performed with multiple individual minicomputers. Hence, with sufficient numbers of small minicomputers, the total computing power might become equal to an ARPANET type installation but would never produce the needed connectivity. Figure 3 of Appendix B shows the interconnectivity requirements at NAS Lemoore for information exchange among units.

The following subsections then discuss each tenant activity individually. What operating problems were found; what connecting to ARPANET could do to solve those problems; what man-hours could be saved; and what increase in expediency and efficiency could be expected are discussed for each.

1. Security

The security department at the naval air station is tasked with all vehicle (automobile, motorcycle, and bicycle) registration, weapons registrations, and pet registration on the station. At the time of this research, there were approximately 10,000 personnel on the station and 7932 vehicles registered. The weapons and pets were those belonging to the individuals living in base housing. The

security department also had the responsibilities typical to any police force, in so far as applications go to on base residents. One of the primary areas where an ARPANET connection would assist the security department is in the administration and file keeping of the myriad of registrations they maintain.

The registration procedure is for an individual to go to security and fill out a form for each vehicle, weapon and pet he owns when checking into the air station. For those living off base, the vehicle registration still applies. The forms contain information such as address, telephone number, insurance carrier, license plate number, decal number and unit to which the individual is assigned.

Once the information is obtained it is manually transposed to a circular cardex file for purposes of 'rapid' access. Additionally, the information is sent to the automated data processing facility, where once each month a computer run is made to reassimilate old data with new, and then obtain a computer readout sorted by name (alphabetical listing), decal number, and license plate number. There is no real-time readout available nor is there real-time input to the files. All searches for information are performed manually by one of the security people on duty at the time.

Discussion of the situation with the security officer and his assistant indicated that the system most likely was accessed an average of sixteen times per day (a 24 hour period). An assessment by the individuals who

worked daily with the system, was that each access of the files required ten to twenty man-minutes. That came to four man-hours per day on file access alone. The figure was arrived at by taking the conservative fifteen minute access time and considering the sixteen accesses per day. The intent of the author is to remain conservative throughout this thesis when estimating man-hour figures. Given that the security department is active 365 days per year, the amount of time spent accessing files in one year would be 1460 man-hours. Repeated exercises with lengthy files, such as the on-line ARPANET directory of users, demonstrated a search for any given name or series of digits to take less than one man-minute of time. The subjective estimate then would be a savings of something over 1360 man-hours per year by using an ARPANET type system.

This estimated savings of just under 57 man-days per year on file access is a tangible benefit. Using the standard Department of Defense monetary values assigned from the comptroller's manual (For purposes of this thesis they were taken from Naval Air Station Lemoore Instruction 7000.1C Enclosure (2) and reprinted as Appendix E.) the dollar savings seen would be $8086.22. More importantly is the capability to have up-to-date, on-line information from the time an individual registers a vehicle or other item and walks out of the security office the first time. With the current procedure, the first individual to register following the monthly printout, does not appear in the

system for another thirty days. With an ARPANET type system the need to send registration files to data processing each month would no longer be necessary. The officer-in-charge of the Naval Data Automation Facility (NAVDAF) at Lemoore researched past months inputs by Security. The average number of inputs per month was 1547. Given that the key-punch operators at that facility can do 110 cards per hour, the input time comes to slightly over 14 man-hours per month for security's files. That savings, in the case of real-time entry at the security office, computes to approximately $900 per year. With real-time entry, the time required would be no greater than is now spent on filling out cards by the registrant and then the transposition of that information to the cardex file.

Additional benefits would be in the area of better force management. Accurate data gathering for time spent at various tasks, numbers of searches made, numbers of total files, etc. could be printed out by computer. Those items are not currently known because to obtain them would require manual counts, an extremely time consuming job. Unless authorized more money to write those programs the information cannot even be obtained from NAVDAF. An ARPANET program could be set up to continuously tally such items. Thus, addition of such a system would become a tool for better management of manpower, task assignments, registration control and criminal activity on the air station. Such a system would also free the middle seniority

military personnel from the desk and allow them to be in the field actually handling security details. According to the Security Officer, that office has been asked to investigate transitioning to an all civilian force. In the case of registration, if an ARPANET type system were available, a civil service secretary (GS-3), as used to keypunch at NAVDAF, could manage the task now performed by two and sometimes three middle grade petty officers.

2. Aircraft Intermediate Maintenance Department

Discussion with the AIMD people at Lemoore revealed that they had already recognized the need for going to a computerized system of some kind. In fact they had already started the administrative procedures to acquire a Wang 2000 series minicomputer system to handle their production control system. Although the minicomputer would be a great asset for their problem solution, it would not solve the problem completely. Most of the data they manage is generated at squadron level, passed to either themselves or supply and eventually processed via the ADP facility (NAVDAF) on station. Hence, the mutual information is either transferred over telephone, via the duty driver mentioned previously or by guard mail. That process sometimes takes as long as three days to be completed. In the interim an aircraft part sits idle and an aircraft is frequently in a non-operational status as a result.

Without trying to become too involved in the specific steps in the process it is necessary to explain the

overall functioning of the various units which work with AIMD. When a pilot writes a discrepancy on an aircraft, the squadron maintenance man troubleshoots the discrepancy to determine its cause. In the case where the problem is due to a bad part, a replacement part is ordered from supply. If the bad part is in a category of parts that can be repaired by the AIMD it is then sent to them. At AIMD a maintenance action form (MAF) is written on the part. A portion of that ticket remains with the part and another portion is placed in a large Visual Information Display System (VIDS) board to maintain location and status of the part. At any given time there are usually 1200 parts (give or take a 100) being processed through AIMD. The parts are entered into one of several status; EX-REP, for expeditious repair; IW, for in work; BCM, for beyond the capability of maintenance (usually meaning it must be sent to a higher level repair facility); and RFI, for ready for installation (meaning it has been fixed). Within IW status there are substatus; BL, for back logged; AWM, for awaiting maintenance (not enough personnel to work on it at the time); and AWP, for awaiting parts. For each change of status the individual work centers (41 total) call production control. Production control then has several individuals who walk from VIDS board to VIDS board moving the MAF to a pocket denoting its new status.

At the end of each day an individual is assigned to manually go through each VIDS board, log on a master sheet

the latest status of each part, and total those in order to insure continuity and currency of the status. That one individual, and sometimes another, spends the majority of a single work shift on that job alone. The overall administrative and supervisory staff to manage that operation is approximately 175. Five to seven individuals per shift are used to change parts status on the boards. What a single individual could maintain on a CRT terminal, is requiring six to eight people to perform manually. According to the chief petty officer in charge of the operation, some 250 to 300 parts are 'lost'. That is not lost in the sense that the parts are misplaced, but lost in that a MAF is often overlooked or missed in the board tally. The MAFs are always found, but that entails retracking through each VIDS board.

The AIMD Officer and his staff have completed a study of the savings available from using a computerized system. The estimated savings in man-hours in the first year is 14,400. Further discussion indicated that this had been under estimated by about 5,500. Using the table in Appendix E and considering the average pay grade at E5 the monetary savings would then be somewhere between $85,536 and $118,206. Such a system would also increase production by putting maintenance personnel back in the productive work centers. The increased flow of RFI parts then would serve to increase operational readiness in the squadrons.

The above data was based on the then current

situation which encompassed processing of only A-7 aircraft parts. With the advent of the F/A-18 at NAS Lemoore in one year, the problem will compound itself. To attempt to think of processing approximately 2500 parts in the same manual fashion is beyond concept.

As had been previously mentioned, all of the foregoing could be managed with a minicomputer if only the inhouse problems were of concern. That was not the case. The need to correlate data and information with the NAVDAF, supply and the squadrons necessitates tying the units together by computer. It would make little sense to have a real-time, on-line computer system capable of responding in microseconds and then be waiting three days for necessary information to come from the other end of the naval air station to be input to that system.

3. Medical

Discussion with the Commanding Officer of the Naval Air Station Hospital Lemoore (NASHL) indicated that he had recognized a need for computerizing many of the processes required in the hospital. He mentioned record keeping and processing of central supply items. He directed the author to his senior flight surgeon who had very specific ideas on the capabilities of a computerized system. Doctor Pantera was not only a qualified doctor and naval flight surgeon, but was also experienced as a computer programmer. A discussion with him revealed that his unit (a dispensary at the operations end of the air station eight miles from the

hospital) had seen the need for computerizing the system. One of his concerns was the problem of misplaced/lost records and particularly the lack of ability to reconstruct those records. He considered a solution to be one with a dumb terminal in each doctor/specialist's office connected into the main system where the records could be maintained in a database.

With both the medical and dental facilities at Lemoore, there were annexes at the operations end of the air station, and the main facilities at the administrative end of the base. Any individual with a complicated case was required to have his record forwarded to the administrative part of the base, and then have it returned when his problem had been solved. That particular situation is not common to all stations but was particularly applicable to Lemoore. Neither man-hours nor a monetary value could be placed on the lost record. The intangibility of the benefit did not negate the need for a solution. The FTP capability of an ARPANET connection would certainly qualify for a solution. The cost to transfer those records manually is estimated to be 400 man-hours and $600 in fuel yearly. Computing man-hour cost from Appendix E produces a figure of $2044 yearly, or a total estimated savings expected of approximately $2650 using an ARPANET system.

Another area Doctor Pantera spoke of was the training of the enlisted personnel, and the continuing education of the nurses and the doctors on the staff. The

training capability of the ARPANET system has already been pointed out. With programs such as MYCIN, PARRY etc. being developed, the limit to what can be done is bound only by the individual planner. Appendix F lists some of the languages available for programming training on the ARPANET. No longer would a group be required before an instructor could consider justification of a training lecture. With individual man-machine interface, the person with a few minutes or an hour would have the ability to sit at a terminal and gain training.

The third and final item mentioned was particularly appropriate to the ARPANET. In addition to the distance between facilities on the station, there exists a delay in transfer of information between the NASHL and Oak Knoll Medical Regional Center in Oakland, California. The most difficult cases are referred to doctors at the MRC. It was frequently in excess of a week for information to return to Lemoore concerning referrals. The delay normally tended to irritate doctors and patients alike. When military individuals are complaining about erosion of benefits, such instances only fuel an already hot fire. More importantly is the adequate and timely treatment of people in need of medical attention. With connections on a packet switching computer network, the appropriate data could return to Lemoore ahead of the patient. The hospital and staff could then have reviewed the case and be better prepared to serve the individual patient.

4. Naval Data Automation Facility

The NAVDAF had all of the automatic data processing (ADP) responsibility on the station. When the author had last been stationed at NAS Lemoore all entry was via card punch and card reader into batch processing. Squadrons would deliver the data from the man-hour accounting and the flight data from the aircraft on a daily basis. The ADP would then print the summary data in limited form on a weekly basis. At the end of the month all of the data was printed out in a master monthly dump. That information was used by the squadrons to fill out the monthly flight time summary report which had to be sent to the Commander, Naval Air Forces, Pacific. Normally the squadrons were able to obtain the data one or two days before the report was required out of the squadron. The delays were due to the method of processing. Discussion with the officer-in-charge indicates this will not change appreciably with the real-time system because of batch processing, and manual delivery of the reports.

In researching this thesis it was learned that the NAVDAF had recently acquired terminals for on-line entry of data. The machines incorporated certain text editing capability to facilitate correcting typographical errors and expediting the process. What had not changed was that the squadrons were still delivering the data in bulk on a daily basis and the only feedback was via the weekly or monthly printouts. With ATSS terminals presently existing in each

squadron, an ARPANET connection would allow real-time entry at the squadron level. Information could even be input following each flight. Access such as that would enable the squadron to have its monthly flight time summary in only a matter of minutes following the last flight of the month. Also there would be no need for an individual to make one or two runs per day by vehicle to carry the information eight miles one way to the NAVDAF.

If only one run was considered, the man-hours spent was still one hour per day or five hours per week. With an average of eleven units that equated to 2860 man-hours or $14,614 per year. That figure did not consider wear and tear and fuel for a total of eleven vehicles. Considering 45,760 miles per year for all the vehicles just on that run, and an average of no greater than 15 miles per gallon of gasoline, it equates to 3050 gallons of fuel, something close to $4,000 at the current price of gasoline.

Inquiries about the transfer of data from the Lemoore NAVDAF to the regional center at Alameda, California revealed that the information must be dumped onto magnetic tape from disk. The tapes are then mailed to Alameda where they are loaded back onto disk for the regional processing. The time and effort to process the magnetic tapes is not significant. What is a factor is the delay of the actual transfer of the information. In what is now becoming a trite phrase, the problem would not exist with FTP capability on an ARPANET system.

5. Light Attack Wing, Pacific

In the training of navy pilots at NAS Lemoore, most of the bombing practice flights occur at NAS Fallon, Nevada. Extensive ranges with scoring equipment are located there. In trying to better ascertain the qualifications and training readiness of the pilots, a system was established approximately five years ago that gave each pilot a personal identifier to be used on the bombing ranges. Codings were also created that identified the type of bombing drop the pilot was making and permitted an accumulation of data for each individual by type weapon, delivery etc.

The ranges record the data for each delivery made. At the end of the day that information is returned to the Fallon air station from the ranges. It is input to the system. At regular intervals the information is printed, mailed to Lemoore and distributed to the squadrons for verification of the information. Once verified it is then manually processed by an individual on the Light Attack Wing, Pacific (Latwing) staff who is charged with keeping those records. This is a process now taking approximately two to three weeks

The staff has started administrative procedures to acquire a Wang 2000 minicomputer to help with the accumulation and processing of that data, but the delay factor will still be present in obtaining the information from NAS Fallon. Here TIP access would enable the ranges to make real-time inputs from the range into a computer file on

a Host computer at the naval station or anywhere else. Then when flights departed the range the data could be FTP'd or mailed via the network, and be available for the pilot's debriefing and verification. The squadron pilots could then forward the verified information to the Latwing staff for same day input. In that manner the Light Attack Wing Commander would have near real-time assessment of his pilot's readiness. In the same light, individual squadron commanding officers could more quickly determine any trends or weak areas in his pilot's training and adjust that training earlier.

The 'E' datakeeping mentioned is for competitive purposes among the pilots and squadrons. Each pilot must make certain minimum qualifications in several areas of weapons, navigation and aircraft handling criteria. For those individuals who exceed a specific higher criteria an E (for excellence) is awarded. The individual pilot E's are tallied throughout the grading period and at the termination of that period the best overall squadron is awarded for its performance. The keeping of that data has been on a totally manual basis. Many man-hours have been spent each year applying the individual scores to various assigned weighting factors to determine winners. Data on over 200 pilots is kept each year. The need has been recognized and will be solved through computer application. However, without an ARPANET type system, the connectivity to the data source at Fallon will remain by means of the mail.

6. Squadrons

By far the most likely to benefit from installation of an ARPANET connection on station would be the individual operating squadrons and the Fleet Readiness Squadrons (FRS). Whereas the other units onboard would gain substantially because of some specific application of the ARPANET system, the squadrons would virtually reap all benefits.

As aircraft and their associated equipment become more and more expensive it becomes more and more paramount that the individuals working on those aircraft have exceptional knowledge of repair procedures. In the work for introduction of the F/A-18 to the fleet, investigation of an Army aircraft troubleshooting aid Logic Model (LOGMOD) has been taking place. The A-7 community has at times in the past invested in various equipment to help foretell the possibility of engine failure. As funding has become more austere and a paucity of both parts and aircraft have begun to become a way of life, it has become most important that maintenace technicians have all the assistance available to locate problem areas.

If a troubleshooting aid were available to the squadrons, it would not only help pinpoint aircraft discrepancies, and reduce the fault isolation times, but it could be used as a training device. With the rule-oriented languages available on the ARPANET (Rita explained in the next portion), such a system could be readily instituted. Hazeltine Corporation, in proposing a computer-based

instruction for the F/A-18 hornet, developed a troubleshooting training aid. Such a program allowed certain malfunctions to be simulated and permitted a maintenance technician to work his way through the system step by step. If the technician made a mistake in his diagnosis, it cost no lives or expensive aircraft damage. By monitoring such progress the middle managers would better be able to control work scheduling and assignment. Such a device could also be used on a regular basis for refresher training with an ARPANET system.

From the standpoint of AIMD's application the squadron could benefit. When a squadron sent a bad part to supply, they could initiate the on-line documents that have been previously generated at AIMD production control. With a cross reference by squadron, and access by squadron to only their parts, they would have real-time readout of what each part status was. The numerous telephone calls to AIMD by the maintenance chief for parts update would be a thing of the past. By having some overall readout capability for all parts processing, such as the system status protocol does for the ARPANET user, the maintenance managers could better estimate where to place work priorities to achieve better readiness.

Training and use of the ATSS at NAS Lemoore has already been discussed. An example of the latter is in the training records of an enlisted maintenance technician. While at A School his training was recorded on the computer

as each phase was completed. Upon transfer to a unit at NAS Lemoore, that information was output from the A School computer to hard copy and sent with the man to NAS Lemoore. On arrival at the FRAMP at Lemoore, that same information was input to NAS Lemoore's Aviation Training Support System computer. It was held there until his transfer, and each additional training evolution meanwhile was added. When the individual was transferred to a unit not home ported at NAS Lemoore then once more the output to hard copy and input to computer at departure and arrival was again required. The record was of course getting more voluminous with each cycle. Once again the individual was transferred and returned to NAS Lemoore. Needless to say the same evolution was repeated. What over the period of transfers took approximately five man-hours to reinput at each base could have been accomplished with the FTP feature in no more than two minutes.

With the on-line terminals in each squadron, the squadrons have remained better informed about the enlisted training. They have also had more input on each individual's specific training. As a result the squadrons have been able to deploy overseas with much better overall training than was ever enjoyed before the ATSS/VTS systems were installed. Without the on-line connectivity and real-time access that would not have been the case.

As discussed in the section for the data processing facility, the squadrons would greatly benefit from the

direct connectivity to NAVDAF. By having the capability for daily aircraft summary readouts, the squadron could more quickly pickup trends in maintenance problem areas. The lost man-hours from driving report material to the NAVDAF could be better allocated in trend analysis, training or management.

Such a system would greatly enhance aircraft maintenance scheduling and maintenance training scheduling. By inputting future needs the computer could be programmed to allow for various deviations in the requirements and produce required completion dates and parts removal dates. No more would the part with a set flight-hour lifetime slip by the maintenance chief without being removed. The safety gains would be intangible but of the utmost benefit to all concerned.

With on-line access to aircraft status by the wing, the night shift maintenance chief would not have to estimate the number of aircraft that would be flyable for the Latwing morning readiness report. The morning shift would be able to simply mail or FTP that information moments before it was required, instead of having the duty driver carry the information there as is presently done. In addition to more accurate data, the staff would have a more realistic idea of what the true readiness of the wing was. By gathering all squadron data on computer, community trends could be more quickly predicted to permit better safety and readiness.

Programs could be written to pick off certain

declared values from files in order to make the monthly recurring report preparation one of simply pushing one or two keys on the terminal. By inputting that information into preformatted messages many man-hours could be saved in the maintenance administration and squadron administration areas. An example of this capability is given under FSAR in the special applications section.

Throughout the year individual squadrons deploy to NAS Fallon for approximately two weeks of intensive flight operations. During that period, aircraft parts are shuttled to Fallon via a private air carrier. The ordering of those parts each day is completed by telephone. Not infrequently there is a misunderstanding as to what has been ordered and consequently a part will not always arrive. Use of a net would permit the building of a file as the part orders are recognized, and then the file could be transferred via net to Lemoore. In addition to increasing aircraft availability by better parts supply, there would be no misunderstanding as to exactly what items were required.

When the squadrons deploy to NAS Fallon, the administrative department normally remains behind at NAS Lemoore. That precludes initiating a mail shift for only the two week period of deployment. What it does however, is to require lengthy telephone conversations each day, informing the commanding officer of what action items have come in at Lemoore. In some instances it necessitates forwarding correspondence to Fallon on the parts transfer

aircraft. In the ultimate use of ARPANET, a user gets all his network mail at his terminal, regardless of where located. It was previously mentioned that the author used the network while at Lemoore TAD during his thesis research. The network cares little where the individual is physically located when logging into his directory. One member of the author's class at NPS went TAD to Hawaii for two weeks. Throughout that time she used the ARPANET daily to keep up to date on assignments.

C. SPECIAL APPLICATIONS

The purpose of this section is to describe to the extent possible, some of the special programs that have been written, by individuals other than the author, that are currently accessible on the ARPANET. The programs chosen are ones with which the author has worked and are examples of the types of aids which can be written and used. All but the MYCIN and RITA are more oriented towards C3 applications. All are indications of what can be accomplished given a little time, programming ability, core space and interconnectivity.

1. QUERY3

Query3 was based on the use of a natural language system man-machine interface and is the follow on to Query2 which stemmed from the Query subsystem. That subsystem was originally established as a text editing/word processing program, and on more or less of a challenge was changed into the very basic query subsystem in a two to three day period.

Dr. John Schill was the designer and programmer. After that initial effort, approximately a month was expended increasing the capability of Query and making it a more useable program from the man-machine interface viewpoint. From there, the effort to turn the program into one which responded to near natural english language commands entailed another six month effort. During that time the program had grown from a standard of only two database commands and a static database of 70 ships, up to one of over thirty commands and a dynamic database of in excess of five hundred ships and aircraft and some one hundred-thirty ports covering both the Pacific and Atlantic Oceans.

Although the Query3 system is a structured system in how the questions have to be asked, it has been found to be very rapid in response and easy to use once that structuring is learned. For the author, the learning period, to a reasonably useful level of accomplishment, was something under five hours. Once that level of competency of the system was reached, the user was able to exercise an optional verbosity feature which greatly increased the speed of response.

With the normal verbosity the system prompts the user and that prompting takes a certain amount of added time which has nothing to do with actually finding the requested data. With minimum verbosity the questions can proceed as sentences as opposed to individual words at a time. An example of the two levels of verbosity follows. Normal

inputs by the user are in the form of one or two letters of the command, followed by a carriage return. The program responses are in capital letters followed by a colon.

```
Full Verbosity:
QUERY3 C: Show C: All (platforms) OK/C: Within
T/[A]: 490 C: Nautical (miles of) C: Me OK:
(Display format?) C: Tabular OK:
   UNK711           HANNINEA
Minimum Verbosity:
QUERY3 C: Show All (platforms) Within 490 Nautical
(miles of) Me Tabular OK:
   UNK711           HANNINEA
```

2. LADDER

Language Access to Distributed Data with Error Recovery, or LADDER, is similar to the previously described QUERY in that it allows the use of english like commands to a database to obtain information. Other than that the two systems are as different as daylight and dark. LADDER is advertised as a nonstructured language. However, it was discovered after some use that when questions are asked in a certain manner the machine responds much more quickly and frequently. LADDER was developed by Dr. Earl Sacerdoti and Dr. Daniel Sagalowicz of Stanford Research Institute. The functional elements of Ladder are three in number. The user asks a question which is processed through a Natural Language Processor and then passed into an Intelligent Data Access and thence to the Large Distributed Databases. Once

the information is obtained the reverse process is followed to present the user with the information in english language text.

As the name implies, there are several databases accessed by LADDER. At the time of writing of this thesis the program had access to fourteen files. The idea of the different files is to simulate a Navy command and control system for the Atlantic Ocean and Mediterranean Sea. Such a system simulates having backup systems which could be accessed in the event of failure, and also demonstrates that not all information would be carried in one database. The databases include information on each ship, aircraft and port, and have characteristics about those particular units and in the case of the movable platforms, includes location and speed data. Where the platform is large enough, information concerning embarked units is also included.

Work on LADDER was begun in 1977 and extended through 1979. In the meantime, work has started on a new system called TED (Transportable English-based Data manager). It will eventually lead into a system called TEAM (Transportable English Access Medium). Both of those have improvements in database access and will show great improvements in the man-machine interface capability.

4. FSAR/SAR

There are two programs for search and rescue on the ARPANET at the time of the writing of this thesis. One named SAR and another named FSAR are for all intents and

purposes generally the same. The FSAR has some features that allow options as to which phase of the search and rescue is to be run next, making it slightly better. The reason for the qualifier is that certain steps have to be performed before others in order for the demonstration to be meaningful. Essentially, the program is designed to simulate a group of individual command positions tied into a single network and furnishing appropriate information on a near automatic basis. In other words, when a search and rescue is initiated, the system is designed to obtain location. Then if a weather report is requested, the system will do a computer to computer link, request a weather report based on the initially entered data for location, search time etcetera, and then return to the main system. The weather, when obtained, is automatically forwarded to the command computer location.

While the weather is being generated by the fleet numerical weather center computer, the command center computer is accessing its database for the 'forstat' (forces status reports) which tells the commander which ships are available, their location and ability to assist. The accessing of this latter data is performed at sites remotely located from the command center computer. The data of Figure 4 of Appendix B shows, for the demonstration program, how the various command levels are distributed to various ARPANET Host locations to simulate the assorted remote sites being accessed.

Once the forstat information is gathered the computer is capable of being called upon for a report assimilation and forwarding. The command center computer is programmed to retain certain pertinent information from the questions it had previously asked the user. That information is then recalled by the computer, entered into appropriate portions of a preformatted message, and then presented to the user for approval/additions before release.

A functioning system would of course have to be classified in order to contain the required forces status reports information. However, by generation of the information only for demonstration, the programs are kept on an unclassified level. FSAR is a simple, straight forward demonstration of some of the command and control capabilities which have been developed on the ARPANET. With very little imagination it is simple to see how such a network installed at the wing level on naval air stations would enable the wing commander to have a real-time readout of squadron status in everything from aircraft and personnel to parts and training. As they currently exist, most wings get a single readout of squadron status once a day in the morning. The requirement aboard ship is even more real for such a system. Where assets determine the action a commander can take in any given tactical situation, it is imperative to have the most recent information available.

4. MYCIN

MYCIN is an experimental medical consultation system

developed at the Stanford University Medical Center in conjunction with the Stanford Research Institute. It was designed to select antibiotic therapy for bacterial infections and includes self-documentation on: 1) commands for starting and using the program; 2) organization and history of the system; and 3) hints that would assist the user in obtaining best results from the system's features.

The development began in 1972 around the idea of a program for assisting physician nonspecialists with the selection of therapy for bacterial infections. Both physicians and computer scientists worked together to achieve that end. Much discussion led to a rule-oriented system that used the specific criteria of defining the decision items necessary for diagnosis. The goal was to be able to model the thought and decision processes used by medical experts. From that, four primary goals were achieved by the program:

1) decide whether the patient had a significant infection;

2) determine the likely identity of the offending organism;

3) decide what drugs were apt to be effective against that organism;

4) choose the drug that was most appropriate, given the patient's clinical condition.

To achieve that goal, approximately 200 decision rules have been identified at the time of writing of this thesis. Those are used to form three in-program systems;

one each for consultation, explanation and rule-acquisition. The consultation system is the first main subsystem and the one through which all others are accessed. It is the system where patient data is requested and input to the system. The explanation system is the one called by the user when he desires to understand how the therapeutic recommendation has been made. The rule-acquisition system was unavailable at that time, but was designed to allow the addition of new rules or to adjust existing rules.

In a sample session then, the program starts by asking the user several questions which lead the program to a diagnosis. Certain typing errors, such as minor misspellings, are overlooked by the system. Large errors can be deleted with normal control functions expected on ARPANET systems. If the user is uncertain of his answer, he is allowed to modify his response. That is accomplished by placing a number from 1 to 10 in parentheses following the answer given. The 10 signifies absolute certainty of the users answer and a 1 virtually indicates that it is a guess. If no entry is made the system defaults to absolute certainty. Additionally, if the user desires to change an answer, the capability exists. One simply types the word CHANGE followed by the number of the question for which the change is desired. If the user does not desire to guess at a question, he can answer unknown. This precludes possibly misleading the program.

In the event the user is not sure what the program

is asking, an optional verbosity feature allows additional detail for the specific question concerned. The user simply types a question mark.

```
Sample Response  [user input follows the "**"]
  Does the patient have a risk factor for
  tuberculosis?
  ** ?
  One or more of the following are considered
  risk factors for tb: a) positive PPD (5TU),
  b) history of close contact with a person
  having active tb, c) household member with
  a past history of active tb, d) chest X-ray
  showing apical scarring, e) granulomas seen
  on biopsy of any organ tissue.

  Expected responses are: YES NO
  Enter HELP for user options.
  ** YES
```

At the end of the session the user is permitted to review the case and if desired can save the file from the session completed.

5. ASTDA

The Analytic Strike Timing Decision Aid is a program that assists the commander (airwing commander, task group commander, etc.) in choosing the most likely time for launching an air strike against opposing forces. Most likely is defined to be the time with the best probability for a successful attack and a safe return to the aircraft carrier. Inputs to the aid include: aircraft readiness figures for the attack and fighter aircraft aboard the aircraft carrier; expected probabilities and percentages for cloud cover enroute to and on return from the target; estimates for the opposing forces status (both air and ground) and the restriction to certain hours for launch and

recovery. The type aircraft are reflected as current fleet and Russian types.

Upon entering the aid, the user is given a menu of the various options that are available to him. These are items such as reviewing readiness status reports for the friendly forces, etc. Once the user is satisfied with all tables, he is able to run the program and then receive a readout of the times for launch, with likelihood of success values given for each.

The essence of the program's working is that it takes all the inputs and uses a Monte Carlo type probability estimation to furnish the values for the various attack times. Figures 5-8 in Appendix B show some of the menu selection tables and the results of a run with that data.

6. SURVAV

To the author the Satellite Surveillance Avoidance Optimization Aid is one of the most impressive. Additionally, its functionality, usefulness and application can readily be seen. The aid is to plot a track for a ship transiting some given geographic area that is covered by Russian satellites. The user is asked several questions by the program in order to achieve its goal. Inputs are items such as the ship's minimum and maximum speeds and the incremental adjustments allowed. Amount of course deviation allowed and amount of total delay allowed are also queries by the program. That information, along with some other minor items, is then compared within the program to furnish

the user with a four faceted output (with graphics).

The first output is a bar graph and listing of the recommended speed of advance for the ship. The second output is a geographic map of that portion of the earth's surface the ship is to traverse, and the position of possible detections by a satellite on that track. There is also a listing with the map giving time, and latitude and longitude for each detection zone. The third item is an intercept avoidance profile comparing distance versus time. The satellite tracks are plotted vertically showing breaks and overlaps in the coverage. Staying within the window given by the user, the program then attempts to draw the ship's proposed track avoiding crossing as many satellite tracks as possible. The final item is a list of potential detection zones listing the type satellite (optical, elint, radar, etc.) and the dates and times of detection.

6. RITA

The Rand Intelligent Terminal Agent was developed at Rand Corporation to work as an intelligent terminal agent computer program. That effort was a part of a larger research effort within the Defense Advanced Research Projects Agency. RITA has been designed as a front end to remote computing systems and networks. Areas of application are seen as command and control systems, maintenance scheduling and control, intelligence collection, automatic message routing and logistics control.

RITA is written in the C programming language and

runs under the Unix systems. It is run on a rule-based system which allows the user to establish the rules for the particular control or problem item. Once the rules have been constructed the program entries are then essentially filtered through several IF-THEN rules to determine the next step. As a function of various object-attribute-values the user stores data in the system. There can be several attributes for a given object, but each must have a distinct name. Normally, an attribute can have a single value, an ordered list of values or no value. For any given item, the data is compared against the IF, and as a function of the premise established, applies some action.

IV. CONCLUSIONS

A. TECHNOLOGY EXISTS TODAY

The rise of computers and their use since the early Mercury space program has been phenomenal. There is no doubt that computers can be adapted to most situations. Today systems exist from the minicomputers used in the individual household to the World Wide Military Command and Control System (WWMCCS). In April of 1978 the U.S. News and World Report[1] pointed out that at that time ten government agencies had 4576 data systems with 2.1375 billion individual's records being maintained on those systems. Of those systems, the Department of Defense had just under one-half of them (2219). At that time the government was buying or leasing better than 1500 new systems each year. With the rapid growth of electronic technology in the past few years, this figure will continue to grow. Ms. Ruth Davis, Deputy Under Secretary for Research and Advanced Technology, discussed the key challenges to C3 in an issue of Defense 80.[5] In that article Dr. Davis spoke of the great advantage that the development of Very High Speed Integrated Circuits (VHSIC) will have on future technology advances in C3. With the capability to design and produce solid state circuitry only one and one-half to two microns thick (a hair is nominally 70 microns thick) the ability to miniaturize and mass produce computers can only continue to

grow at unprecedented rates. At the same time the costs of those systems will drop greatly. The hand held calculator is a prime example of how prices rapidly make a downward spiral with increased production.

With the advent of that technology into the market place, and the role the computer has gained in the defense department, it has become incumbent upon each manager to understand the increased capabilities that exist; the increased requirement for proper responsibility to management of those systems; and the necessity for properly applying the existing technology to better connectivity and performance of his job requirements.

B. COST IS RELATIVELY INEXPENSIVE

When speaking of cost, the first thought was that the ARPANET was a very expensive system to install and maintain for NAS Lemoore. If a unit or organization were to be starting from zero assets, or if a unit had not previously considered installing computer equipment at all, then that assumption was generally a good one. In the instance of considering installation of ARPANET TIP's at Navy sites, the whole picture needs to be examined against a minimum of three items, relative cost, interconnectivity, and existence of necessary equipment.

At Lemoore, there are currently three existing systems, two other units have initiated administrative procedures for procurement, and an additional three other activities show desire for and would benefit from computers. Those units do

not include the ten operational squadrons stationed at Lemoore which also can gain benefits from a computer system. Purchase of minicomputer systems for each of those activities is estimated to be $60,000. That estimate is based on GSA prices submitted by Wang Laboratories, Incorporated. If only six of the squadrons are considered to be at Lemoore at one time, the total requirement would be for eleven additional units. The initial costs would come to $660,000 for sufficient minicomputers to support the units needing them. The yearly maintenance cost (based on an estimate for the Wang 2000 system by company individuals) would be $6,048 per system, or $66,528 per year for the eleven systems. A breakdown of these costs is shown in Figure 2 of Appendix G.

If these figures are compared to the estimated installation cost of $100,000 for the ARPANET TIP (with two PDP-11's), plus $64,000 yearly fees for ARPANET maintenance, the minicomputer amounts are six times higher. The price for that TIP installation is for a system that would support 20 terminal ports. The significant factor is that only with an ARPANET system can the individual units on the station have connectivity with each other and with units on other Hosts. The estimated cost for that connectivity of twenty units is significantly less than eleven individual minicomputers. Core time and accounts could also be established for units such as the commissary, and the navy exchange which would reduce costs further. Considering the

savings discussed previously in this thesis (man-hours, fuel, etc.) the cost for an ARPANET connection would be considered less. From that standpoint, the cost is relatively inexpensive. It is believed by this author that with such a system, more and more new ways to utilize the connectivity for increased savings in man-hours would be realized as system familiarity increased, which would decrease monthly factors even more.

C. THE NEED FOR INTERCOMPUTER CONNECTIVITY EXISTS

The reader might conclude that this thesis has been dwelling on the need for connectivity of computers among units at the naval station. That conclusion is valid. It was that interconnection of data flow which so impressed this author when he was exposed to the ARPANET. It was the same connectivity that instilled the thought of many man-hours of savings at naval installations. It was the same transfer of information that was required to keep the commander informed of enemy actions, that was lacking in United States bases where commanders needed to know what their own forces were doing. That has been the case at every installation on which the author has served since 1963. If the counter to that would be that computers have not existed in quantity, then maybe it is time to plan for the future and the advent of a highly computerized navy, defense department, and nation. Living in a world where missiles can reach halfway around that world in less than half an hour, it is folly to tolerate continued manipulation

and transfer of information by manual means. It will be the commander who has an adequate grasp of proper command, control and communications that will be the qualified officer, leader, and manager of the navy of the eighties. Only with such systems will the commander be able to properly utilize the ever decreasing availability of personnel, petroleum and other resources so necessary for readiness. The interconnectivity is required.

That some individuals have recognized the need for interconnectivity is recognized by the existence of interconnecting systems. The ATSS units at most naval air stations, and the Airborne Weapons Corrective Action Program (AWCAP) in the Navy are examples of working interconnected systems. The ATSS has been discussed. The AWCAP system ties together seventeen activities from California to Missouri to Washington, D.C. It is used only for processing weapons information, but its use does show the need for interconnectivity has been recognized.

D. THERE WOULD BE A SAVINGS IN RESOURCES

Within the limited scope of the author's assessment of only one naval installation, it has been shown that such a system could reduce man-hours, fuel and vehicle costs, and time lost to data transfer at NAS Lemoore. These valuable assets become more and more critical to readiness with each passing day. The United States Army recently pointed out that the average education level of the new enlistee has been dropping since the end of the draft. Likewise, nearly

one-fourth (23 percent) of the U.S. Navy enlistees in 1979 did not have a high school diploma.[12] The volunteer service is not drawing the better educated, highly motivated individual. General Donald Starry, head of the Army Training and Doctrine Command, stated that sixty percent of the Army's recruits are below average in intelligence.[18] The Army Times reported that most enlistees read at or below the eighth grade level, one in five read at the seventh grade level, and a few read at a third grade level. General Bernard W. Rogers, while the Army Chief of Staff in 1978, ordered all manuals rewritten to a seventh grade level.[13] The existing new technologies must be included in day to day operations if the limited resource of quality individuals is going to continue to be able to carry the burden of constant readiness.

As OPEC prices have increased, this nation has seen the great cutbacks on fuel for cars, aircraft, and homes. Again, another resource required for adequate readiness has come into short supply. The rising prices of that asset are hard to discuss because they increase almost daily. The more those assets are saved, the better this nation will be until it can develop new energy needs. The electronic transfer of data, information, and mail can lead to some of those savings. Figure 9 of Appendix B shows some of the savings in resources for NAS Lemoore. These savings amount to slightly more than three times the amount charged for annual maintenance and operating costs on the ARPANET.

E. EQUIPMENT EXISTS FOR INCORPORATION

Every major naval air station currently has an active VIS or ATSS system. With that existing equipment, an ARPANET installation would cost only about one-sixth or one-seventh as much as if the equipment were not there. Lemoore naval station has a PDP-11/70, two RPL-4s, one magnetic tape unit, one high speed printer, six low speed printers (LA-36), and 46 terminals. That equipment is tied to the ATSS and because of ATSS requirements is virtually limited for use only with the Fleet Readiness Aviation Maintenance Program. Once on an ARPANET system, directories could be established at other facilities for small monthly fees. The author had two directories at Information Sciences Institute at the University of Southern California. The monthly charge during the heaviest usage (averaging 4-5 hours per day, seven days a week) was under $100. Two free directories were requested and obtained at the Massachusetts Institute of Technology. Another free directory on a Unix system was discovered but never utilized. Thus, from an existing equipment standpoint, it would be no major task to be connected to ARPANET.

F. ADDITIONAL RESEARCH IS NEEDED

This thesis has made an assessment based on only one naval station. Because of limited time for research and data gathering, inability to place a dollar figure on many intangible benefits of the system, and inability to research such a project on a navywide basis, the results of this

thesis are of course incomplete. Insofar as the ultimate savings and benefits possible, were the United States Navy to incorporate a computer to computer packet switching network navywide, more research would be needed. It would be this author's recommendation that a test system be established at an individual base and recorded data of such a system be analyzed to determine more detailed cost effectiveness.

APPENDIX A

LIST OF ACRONYMS AND GLOSSARY

AIMD - Aircraft Intermediate Maintenance Department

ACCAT - Advanced Command and Control Architectural Testbed

ADP - Automated Data Processing

ARPANET - Advanced Research Projects Agency Network

ASCII - American Standard Code of Information Interchange

ATSS - Aviation Training Support System

AWCAP - Airborne Weapons Corrective Action Program

AWM - Awaiting Maintenance

AWP - Awaiting Parts

BCM - Beyond the Capability of Maintenance

C - A programming language on Unix systems

C3 - Command, Control and Communications

CRT - Cathode Ray Tube

DARPA - Defense Advance Research Projects Agency

DCA - Defense Communications Agency

DISK - An on-line real-time access and storage device

DUMP - Output of information from a computer system

EXREP - Expeditious Repair

FNWC - Fleet Numerical Weather Center

FRAMP - Fleet Readiness Aviation Maintenance Program

FRS - Fleet Readiness Squadron

HOST - A customer owned computer connected to an IMP

IMP - Interface Message Processor, a store and forward packet switch

ISI - Information Sciences Institute, a Host at USC

IW - In Work

LADDER - Language Access to Distributed Data with Error Recovery

LOGMOD - Logic Model

LOI - Letter Of Instruction

MAF - Maintenance Action Form

MAGTAPE - Magnetic Tape

MBB - Microprogrammable Building Blocks

MSG - A mail handling program at ISI

NAS - Naval Air Station

NASHL - Naval Air Station Hospital Lemoore

NAVDAF - Navy Data Automation Facility

NED - New Editor, a text editor on Unix

NRMC - Naval Regional Medical Center

NROFF - A program for text formatting

NVT - Network Virtual Terminal

PSD - Personnel Support Detachment

PIMP - Pluribus Interface Message Processor

PTIP - Pluribus Terminal Interface Processor

QUERY3 - A natural language man-machine query system

RFI - Ready For Installation

SECNAV - Secretary of the Navy

SRI - Stanford Research Institute, a host at Stanford

TAD - Temporary Additional Duty

TEAM - Transportable English Access Medium

TECO - A text editor at ISI

TED - Transportable English-based Data manager

TELNET - A protocol for giving commands to a computer

TIP - Terminal Interface Processor, a store and forward packet switch which can accommodate terminals

UNIX - An operating system using the C programming language

VIDS - Visual Information Display System

VTS - Versatile Training System

APPENDIX B

COMPILATION OF FIGURES

EXISTING EQUIPMENT AT NAVAL AIR STATION LEMOORE

ITEM	QTY
PDP 11/70	1
RPL-4	2
MAGNETIC TAPE UNIT	1
HIGH SPEED PRINTER	1
LOW SPEED PRINTER (LA-36)	6
TERMINALS (ADM-3)	41
TERMINALS (MISC)	5
MODEMS	51

Figure 1.

ESTIMATED COSTS FOR INSTALLATIONS
AND RECURRING MONTHLY MAINTENANCE

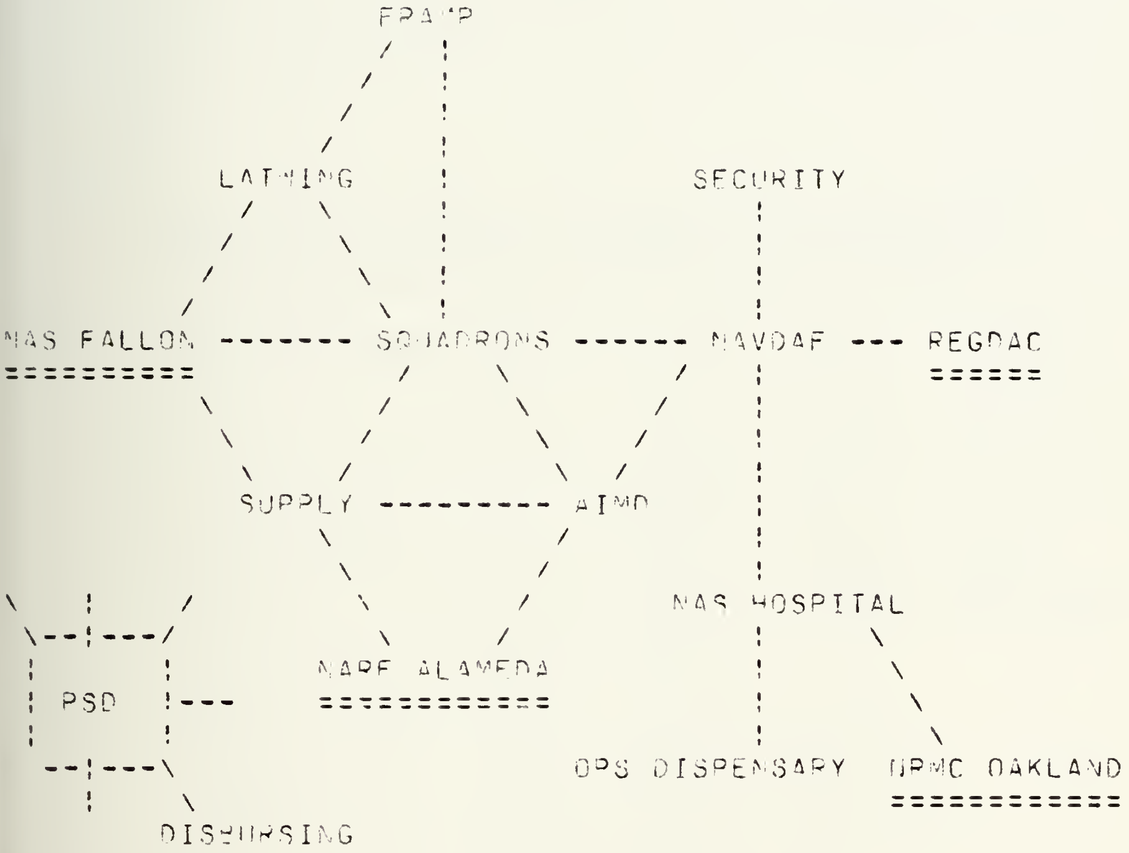
ITEM	WANG LAB. Initial	WANG LAB. Monthly
WANG 2200 SYSTEM		
2200MVP-32	$15,280	$160
2260C(Disc Drive)	10,505	100
2236DE(Wkstn 8)	20,628	128
2236MXD(Cont 2)	2,292	16
2221W(Prtr 2)	9,550	96
22C02(PrtrCntl 2)	382	4
CABLE(1000 ft.)	700	
TOTALS	$59,337	$504
COST FOR ELEVEN SYSTEMS	$652,707	$5544

	ARPANET Initial	ARPANET Monthly
2 MODEM, 3 HOST PTIP	$76,000	$6,496
HOST INTERFACE	3,100	0
SOFTWARE LIC.	12,500	0
2 PORT LIU(10)	4,310	0
TOTALS	$95,910	$6,496

TOTAL COST IS FOR A TWENTY PORT SYSTEM.
WITH THE EXISTING EQUIPMENT AT NAS LEMOORE
CAN HAVE FORTY INDIVIDUAL UNIT DIRECTORIES
WITH ACCESS AVAILABLE TO HALF AT ANY ONE TIME

Figure 2

INTERCONNECTIVITY DIAGRAM FOR NAS LEMOORE



1. THE PSD OFFICE REQUIRES CONNECTIVITY TO ALL STATION ACTIVITIES. SQUADRONS CURRENTLY MAINTAIN THEIR OWN PERSONNEL RECORDS.

2. THE DOUBLE UNDERLINE (===) INDICATES AN OFF STATION ACTIVITY FOR WHICH CONNECTIVITY IS REQUIRED.

Figure 3.

COMPUTER TO COMPUTER CONNECTIONS SIMULATING A COMMAND AND CONTROL NETWORK IN THE FLEET

C2NETCONTROL	Calif.	(ISI)	Mass.	(BBNA)
xCNO	Mass.	(BBN)	Mass.	(BBNB)
xCINCPACFLT	Calif.	(ISIC)	Calif.	(ISI)
xCINCLANTFLT	Mass.	(BBN)	Mass.	(BBNA)
xFNWC	Calif.	(ISIC)	Calif.	(I4-TENEX)
xC3F	Calif.	(ISIC)		
xC7F	Calif.	(ISIC)		
xC2F	Mass.	(BBNA)		
xC6F	Mass.	(BBN)		

Figure 4.

```
READINESS AND WEATHER REPORT TIME DATA - ASTDA
----------------------------------------------

                        WHEN PREPARED  TIMES COVERED

     REPORT TYPE         DAY   TIME     DAY  TIMES
     -----------         ---   ----     ---  -----

BLUE FORCE READINESS      2    2200      3   0800-1300

ORANGE AIR DEFENSES       2    2200      3   0800-1300

ORANGE GROUND FORCES      2    2200      3   0900-1400

WEATHER AT CARRIER        2    2200      3   1000-1500

WEATHER AT TARGET         2    2200      3   0900-1400

DOES THIS INFORMATION REQUIRE UPDATING BEFORE
THE DECISION AID IS RUN?-NO

FOR STRIKE ON DAY  3:
EARLIEST POSSIBLE STRIKE TIME      0800
LATEST POSSIBLE STRIKE TIME        1300
ALL STRIKE TIMES ARE ASSUMED TO HAVE EQUAL
PRIOR TIME PREFERENCES

 DO YOU WISH TO CHANGE STRIKE DAY? NO

 DO YOU WISH TO CHANGE STRIKE TIMES? NO

 DO YOU WANT TO CHANGE THE PREFERENCE FACTORS? NO

** HIT RETURN KEY TO CONTINUE **
```

Figure 5.

```
TABLE OF UTITLITIES FOR THE MISSION
-----------------------------------


              UTILITIES
TIME        AVG. UTILITY       RANGE
0800             22.15     ( -22.93-   52.00)
0900             29.54     ( -14.10-   57.00)
1000             39.60     (   5.00-   66.12)
1100             42.96     (   9.63-   73.00)
1200             41.56     (   3.00-   73.33)
1300             45.71     (  13.23-   75.00)
```

Figure 6.

```
SELECT ABBREVIATION FOR DISPLAY DESIRED
---------------------------------------

EU      TO DISPLAY EXPECTED UTILITIES VS. STRIKE TIME

BFL     TO DISPLAY BLUE FORCE LOSSES VS. STRIKE TIME

ORGL    TO DISPLAY ORANGE GROUND LOSSES VS. STRIKE TIME

ORAL    TO DISPLAY ORANGE AIR LOSSES VS. STRIKE TIME

RETURN  TO RETURN TO THE MAIN SELECT-DISPLAY MENU

HELP    TO REDISPLAY THIS TABLE
```

Figure 7.

LOSS/STRIKE TIME CHART - ASTDA

ORANGE AIR LOSSES VS. STRIKE TIME

TIME	OF1		OF2	
	AVG. LOSS	RANGE	AVG. LOSS	RANGE
0800	2.3	(1.0- 3.6)	5.2	(2.4- 8.0)
0900	2.5	(1.0- 3.7)	5.7	(3.0- 8.6)
1000	2.9	(1.3- 4.0)	6.5	(3.9- 9.2)
1100	3.2	(2.0- 4.9)	6.9	(4.0-10.0)
1200	3.4	(2.0- 5.0)	7.1	(4.1-10.0)
1300	3.6	(2.0- 5.1)	7.4	(4.2-10.0)

Figure 8.

ESTIMATED UNIT SAVINGS IN RESOURCES

AREA	MAN-HOURS	MONETARY	OTHER
AIMD	14,400	$ 85,536	$ 0
MEDICAL	400	2,650	600 (Fuel)
SECURITY	1,808	9,906	0
ADP	2,860	14,614	4,000 (Fuel)
SQUADRONS	12,480	74,131	0
LATWING	185	2,732	0
TOTALS (Yearly)	32,133	$189,569	$4,600

Figure 9.

APPENDIX C

COMPUTERS USED ON ARPANET

The following information was taken from the ARPANET Resources Handbook, and is a list of the known computers being used on the ARPANET. The list is arranged by manufacturer.

- BBN
  - PLI
  - PLURIBUS
  - VDA

- BURROUGHS
  - B-5500
  - B-6700
  - ILLIAC-IV

- CDC
  - CDC-3200
  - CDC-6400
  - CDC-6500
  - CDC-6600
  - CDC-6700
  - CDC-7600

- CULLER HARRISON
  - AP-90
  - FPS-AP-120B
  - MP-32
  - MP-32A

- DIGITAL EQUIPMENT CORPORATION
  - DEC-10
  - DEC-1050T
  - DEC-1070T
  - DEC-1077T
  - DEC-1080T
  - DEC-1090T
  - PDP-11
  - PDP-11s
  - PDP-11/10
  - PDP-11/20
  - PDP-11/20s
  - PDP-11/34
  - PDP-11/35
  - PDP-11/40
  - PDP-11/40s

```
     PDP-11/45
     PDP-11/50
     PDP-11/70
     PDP-15
     DEC-2040T
     DEC-2050T

DATA GENERAL
     NOVA-800

HONEYWELL
     G-4080
     H-316
     H-6000
     H-6180
     H-68/80

IBM
     3033s
     360/40
     360/44
     360/67
     360/75
     360/91
     360/195
     370/158
     370/168
     370/195

SPS
     SPS-41

UNIVAC
     1108
     1110

VARIAN
     73

XEROX
     MAXC
     MAXC2

OTHER
     ICL-4/72
     NORD-10
     STARAN-1000E
     TI-ASC
```

APPENDIX D

UNITS VISITED AND POINTS OF CONTACT

The following list constitutes the individuals at Naval Air Station Lemoore, California with whom the author had contact during the investigation of this thesis.

UNIT	INDIVIDUAL		PHONE
Naval Air Station	Capt.	L.B. Keely	949-3121/3122
Light Attack Wing	Lcdr.	W. Siegel	949-3072/3631
AIMD	W03	R. Ramstad	949-3293
Fleet Introduction	AZCS	F.D. Harrell	949-3460/3113
Medical	Lcdr.	D. Pantera	949-3434
NAVDAF	Lt.	J. Adams	949-3040
PSD	Lt.	C. Smothers	949-3351
Security	Mr.	M. Timson	949-3306
VA-122	Ens.	B. Dunn	949-3012/3639
VA-127	Cdr.	J. McAuley	949-3574/3575
VA-195	Lt.	H.A. Cart	949-3195

The above phone numbers are for AUTOVON contact. If calling on a commercial line the numbers are 1-209-998-XXXX.

APPENDIX E

COMPOSITE STANDARD MILITARY RATE TABLE

The following table is extracted from information in the Comptroller's Manual and may also be found in the current Naval Air Station Lemoore Instruction 7000.1 Series. Since military personnel are paid on a monthly scale and are not set on a forty-hour work week, the Composite Standard Military Rate Table is used to estimate man-hour costs whenever needed. For purposes of this thesis the following table is applicable for all man-hour cost computations.

PAY GRADE	HOURLY RATE
O6	$21.61
O5	17.69
O4	14.77
O3	12.57
O2	9.50
O1	6.96
W4	13.48
W3	10.94
W2	9.48
E9	11.67
E8	9.95
E7	8.54
E6	7.21
E5	5.94
E4	5.11
E3	4.45
E2	4.08
E1	3.67

APPENDIX F

COMPUTER LANGUAGES USED ON THE ARPANET

This appendix is constructed to indicate some (not all) of the different computer languages that have been found at various locations on the ARPANET. Where found at the using servers, or previously known of by the author, short definitions are given for that entry. Too often during the research and demonstration phases of this thesis the question was asked, "What programming language is used on the system?" The initial response was a figure of about twenty. This not all inclusive list has forty-seven entries.

AID	Conversational programming language
ALGOL/ALGOL-68	Algorithmic language
APLCOM	Translates structured APL into pure APL
BASIC	Conversational problem solving language
BCPL	Transportable language by XEROX
BLIMP	Local L6 derivative at Lawrence Berkeley Lab
BLISS-11	Version of Bliss for the PDP-11
C	A programming language on the Unix system
CALC	Interactive graphics based on KNFJI with a SAIL-like syntax
COBOL	Common business oriented language
COMPASS	Working as a CDC assembler
CONNIVER	High level language embedded in LISP
ECL	Conversational extensible language from Harvard

FORTRAN	Formula translation language
FTN4	Uses CDC Fortran4 compiler
FUZZY	High level artificial intelligence language
INTERCOM	Interactive command language
ISPS	New implementation of Instructional Set Processor description language
KNEJI	Kernel of an interactive language system
L* / L*(I)	Interactive system building
L10	Algorithm like language
LEAP	Associative language with list processing capability (part of SAIL)
LISP	BBN-Symbol manipulating language
LOGO	No documentation - used at XEROX PARC
LSIA	Like L*(I) an interactive system building system developed at CMU
MACLISP	MIT form of LISP for use in artificial intelligence research
MDL	Interactive interpreter similar to LISP but with more data types
MICROSOL	Semantic network language of UCSD
MIDAS	Assembler language used at MIT on DEC 10
MLISP	LISP with algorithm-like syntax
MLISPC	Like MLISP but feeding LAP or LSP versions
MNF	A Minnesota FORTRAN
PASCAL/PASCALP	BY Wirth of Switzerland
PL/1	New York University programing language
POOMAS	Set of BLISS routines allowing construction of SIMULA-like simulation programs
PPL	Conversational extensible language built upon an APL-like syntax
PSTISP	Translates ISPL and ISPS

SAIL	Super set of ALGOL-60
SIMSCRIPT	A language used with simulation modeling
SIMULA	No documentation given - used at CMU-10A
SITBOL	High speed version of SNOBOL
SNOBOL	A DEC-10 version of string process language
WILE	A language by Dave Wile of CMU-10A
ZOG	A query language

COMPUTER OUTPUT

```
        This is a demonstration of a training type  program
        using the ARPANET by means of a Unix system.  This
        short program is to show some of the ways in which
        the system can be used to train and test individuals
        via a CRT terminal.  There are two sets of information
        with several questions for each.  Each question has 4
        possible selections.  After those selections are typed
        on the screen, input the number (1-4) of your choice.
        For wrong choices, the explanation details why it was
        incorrect.  Good Luck.  Enjoy yourself.

        Additionally, other options are available to you
        throughout this program.  If you type:

            the letter n - you skip to the next question.
            the letter r - you return to the previous question.
            the letter i - you will receive instructions.
            the letter q - you will quit the session.

        Immediately after any input, depress the 'return' key.


        Enter the letter of the file of questions you desire
        to see.
            a  ARPANET Knowledge
            b  Plane Captain's Duties
a

  You have chosen the ARPANET Knowledge Set.

        1.  ARPANET was developed by?

                1  Joe Arpa, a professor at NPS
                2  Alfred R. Panet, a french engineer
                3  Advanced Research Projects Agency
                4  Gary Poock, a professor at NPS
3

        Correct. You obviously paid attention while reading the
        introduction to the thesis on feasibility of installing
        ARPANET systems at naval installations.  Continue.

        2.  An ARPANET nodal connection for five or more Hosts
        and up to 63 terminal connections is called: ?

                1  Interface Message Processor (IMP)
                2  Pluribus Interface Message Processor (PIMP)
                3  Terminal Interface Processor (TIP)
```

```
            4  Plurious Terminal Interface Processor (PTIP)
4

      Correct.  The PTIP can accommodate in excess of 18
      host computers, and can accommodate 63 or more
      terminals, depending on its configuration.

      3.   A program not yet running on the ARPANET is: ?

            1  LADDER
            2  QUERY3
            3  RITA
            4  ROSIE
4

      Correct.  ROSIE is a step up from RITA and is still in
      the development stages.  It should soon be available.
      Go on to the next question.

      4.   That unit within the Advanced Research Projects
           Agency called ACCAT is: ?

            1  Aviation Carrier Controlled Approach Team.
            2  Advanced Command Control Architectural Testbed.
            3  Advanced Carrier Control Aircraft Trainer.
            4  Advanced Combat Certification Army Team.
2

           Correct.  The job of ACCAT is to develop, test
           and evaluate new command, control and
           communications (C3) systems for the U.S. Navy.

      5.   MYCIN is: ?

            1  A medicine given to sailors overseas.
            2  A perfume advertised on television.
            3  A program to assist in antimicrobial therapy.
            4  A more powerful form of anacin.
3

      Correct.  MYCIN like CONGEN, and PARRY is a program
      developed at the Stanford University Medical Center.

      This completes the short file on ARPANET Knowledge.
      Do you desire to try the Plane Captain's Duties?

         1  Yes, I want the Plane Captain's Duties section.
         2  I want the ARPANET Knowledge section over again.
         3  I just want to stop for now.
3


      Did you get finished with all parts?
      Are you sure you want to stop the program?
```

```
                                1  YES!!!!
                                2  No.
1
```

BIBLIOGRAPHY

1. Bacon, D.C. and Kelly, O., "Uncle Sam's Computer Has Got You," U.S. News and World Report, v. 84, n. 14, p. 44-45, 10 April 1978.

2. Bilofsky, W., The CRT Text Editor NED, Rand, 1977.

3. Bisbey, R.II, and others, GL2 Manual, on-line, 1979.

4. Bolt, Beranek and Newman, Inc., User's Guide to the Terminal IMP, NIC#10916, B,B & N, 1976.

5. Brown, H., Exploring Technology, Command Policy, v. 2, n. [illegible], AFIS, 1979.

6. Davis, R.M., Technology Trends in Communications, Command and Control, Defense 80, v. 1, n. 1, AFIS, 1980.

7. Defense Communications Agency, Arpanet Information Brochure, DCA, 1979.

8. Feinler, E.J., Arpanet Resources Handbook, NIC#45601, Stanford Research Institute, 1978.

9. Heathman, M., MYCIN User's Guide, Stanford University Medical Center, 1979.

10. Hill, J.A., Fielding a Modern Ready Air Force, presented at AFCEA Washington Chapter, April 1979.

11. Information Sciences Institute, Resource Sharing Executive, on-line, USC, 1979

12. Pirie, R.B., The Continuing Military Manpower Crunch, presented at the Pentagon press conference , 25 October 1979.

13. Rogers, A., Recruit Reading Level Drops to Eighth Grade, Army Times, 11 February 1980.

14. Sacerdoti, E. and Sagalowicz, D., LADDER User's Manual, on-line, Stanford Research Institute, 1979.

15. Smith, P., Machines Cut Paperwork for Fleet Sailors, Navy Times, 1 October 1979.

16. Stanford Research Institute, FTP.DOC, on-line user's manual, SRI, 1979.

17. Stanford Research Institute, SPELL.DOC, on-line user's manual, SRI, 1979.

18. Starry, D., Sixty Percent of Army Recruits Below Average Intelligence in 1978, Monterey Herald, 17 October 1979.

19. Yonke, M.D., NETMAIL Documentation, Information Sciences Institute, 1979.

INITIAL DISTRIBUTION LIST

No. Copies

1. LT Jan Adams, USN 1
Officer-in-Charge
Navy Data Automation Facility
Naval Air Station
Lemoore, California 93245

2. LT Harold A. Cart, USN 1
Fleet Introduction Team
Light Attack Wing, Pacific
Naval Air Station
Lemoore, California 93245

3. Defense Technical Information Center 2
Cameron Station
Alexander, Virginia 22314

4. William Dejka, Code 8302 1
Naval Ocean Systems Center
San Diego, California 92152

5. LT Richard DeLong, USN 1
Security Department
Naval Air Station
Lemoore, California 93245

6. LCDR Jack Dietzler, USN 1
Advanced Research Projects Agency
Information Processing Techniques Office
1400 Wilson Boulevard
Arlington, Virginia 22209

7. ENS Robert Dunn, USN 1
Fleet Readiness Aviation Maintenance Program
Attack Squadron ONE TWENTY-TWO
Naval Air Station
Lemoore, California 93245

8. CAPT James M. Gleim, USN 1
Commanding Officer
Naval Air Station
Lemoore, California 93245

9. CAPT Leonard Giuliani, USN 1
Commanding Officer
Naval Air Station
Fallon, Nevada 89406

10. CAPT Roland Raup, USN 1
Light Attack Wing, Pacific
Naval Air Station
Lemoore, California 93245

11. CDR Jack McAuley, USN 1
Commanding Officer
Attack Squadron ONE TWENTY-SEVEN
Naval Air Station
Lemoore, California 93245

12. CDR William Paschall, USN, Code OP 0981 1
Chief of Naval Operations
Washington, D.C. 20350

13. CAPT Frank Pittington, USN 1
Commanding Officer
Naval Hospital
Naval Air Station
Lemoore, California 93245

14. Professor Gary K. Poock, Code 55Pk 5
Department of Operations Research
Naval Postgraduate School
Monterey, Californa 93940

15. W03 Robert Ramstad, USN 1
Aircraft Intermediate Maintenance Department
Naval Air Station
Lemoore, California 93245

16. CDR Michael G. Shaw, USN 5
Attack Squadron ONE TWENTY-TWO
Naval Air Station
Lemoore, California 93245

17. LT Curtis Smothers, USN 1
Officer-in-Charge
Personnel Support Detachment
Naval Air Station
Lemoore, California 93245

18. C.C. Stout, Code 330 1
Naval Electronics System Command
2511 Jefferson Davis Highway
Arlington, Virginia 20360

19. Bruno Witte, Code 8302 1
Naval Ocean Systems Center
San Diego, California 92152

20. CAPT Fredrick L. Westover, USAF 1
Defense Communications Agency
Command Control Technical Center/C600

11440 Issac Newton Square (North)
Reston, Virginia 22070

21. Group Chairman, Code 74 1
Command, Control and Communications Academic Group
Naval Postgraduate School
Monterey, California 93940

22. Library, Code 0142 2
Naval Postgraduate School
Monterey, California 93940

Thesis 188631
S43733 Shaw
c.1 A feasibility study of incorporating ARPANET type technology at United States Naval installations.

thesS43733
A feasibility study of incorporating ARP
3 2768 001 94396 2
DUDLEY KNOX LIBRARY